AD722168

DETACHMENT 1, 17TH WEATHER SQUADRON
7TH WEATHER WING
AIR WEATHER SERVICE (MAC)

TERMINAL FORECAST REFERENCE FILE

TINKER AFB, OKLAHOMA

MARCH 1971

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C O N T E N T S

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S E C T I O N I

LOCATION, TOPOGRAPHY AND INSTRUMENTATION

TINKER AIR FORCE BASE, OKLAHOMA

1. Location and Topography

Tinker Air Force Base is located approximately seven miles east southeast of Oklahoma City, Oklahoma, at 35° 25' north latitude and 97° 24' west longitude. The field elevation is 1,291 feet above mean sea level.

The Tinker-Oklahoma City locality lies on the border of the two major topographic regions to be found in the State of Oklahoma. To the west is a slightly rolling prairie, sloping gently from west to east with an average fall of eight feet to a mile. The highest point in this section is the Black Mesa at about 4,500 feet MSL. The elevation decreases to less than 900 feet in the Red River Valley near the southern boundary of the state. The west-central section of Oklahoma is a nearly level plain with little hill country and practically no timber. In the southwest, the Wichita Mountains, consisting of a number of scattered peaks, extend for about 60 miles east and west. These peaks rise to a maximum of 2,479 feet with an average elevation of 1,000 to 1,200 feet above the surrounding plain. The only extensive wooded tracts in Western Oklahoma are found in these mountains.

East of Tinker the land still slopes to the south and east. The northern portion is a rolling and somewhat broken prairie country with a general elevation of 800 to 1,000 feet. There are no mountains or hills of any significant elevation. However, in the extreme northeast the extension of the Ozark Mountains form a broad plateau with a general elevation of about 1,100 feet with scattered ridges rising 200 to 300 feet above the general level. In the southeast, the long, narrow, parallel ridges of the Ouachita Mountains rise to heights of 2,500 to 2,900 feet MSL.

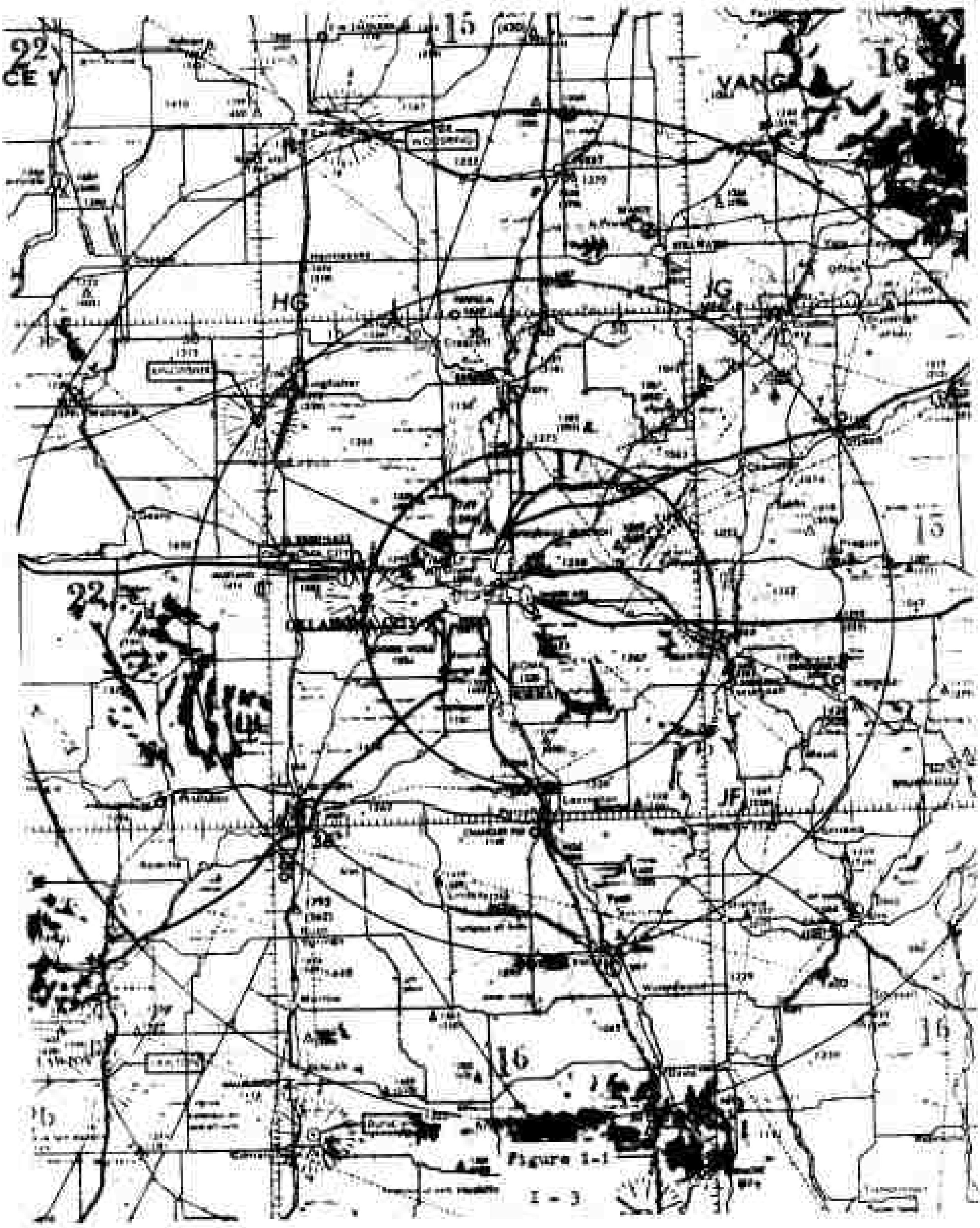


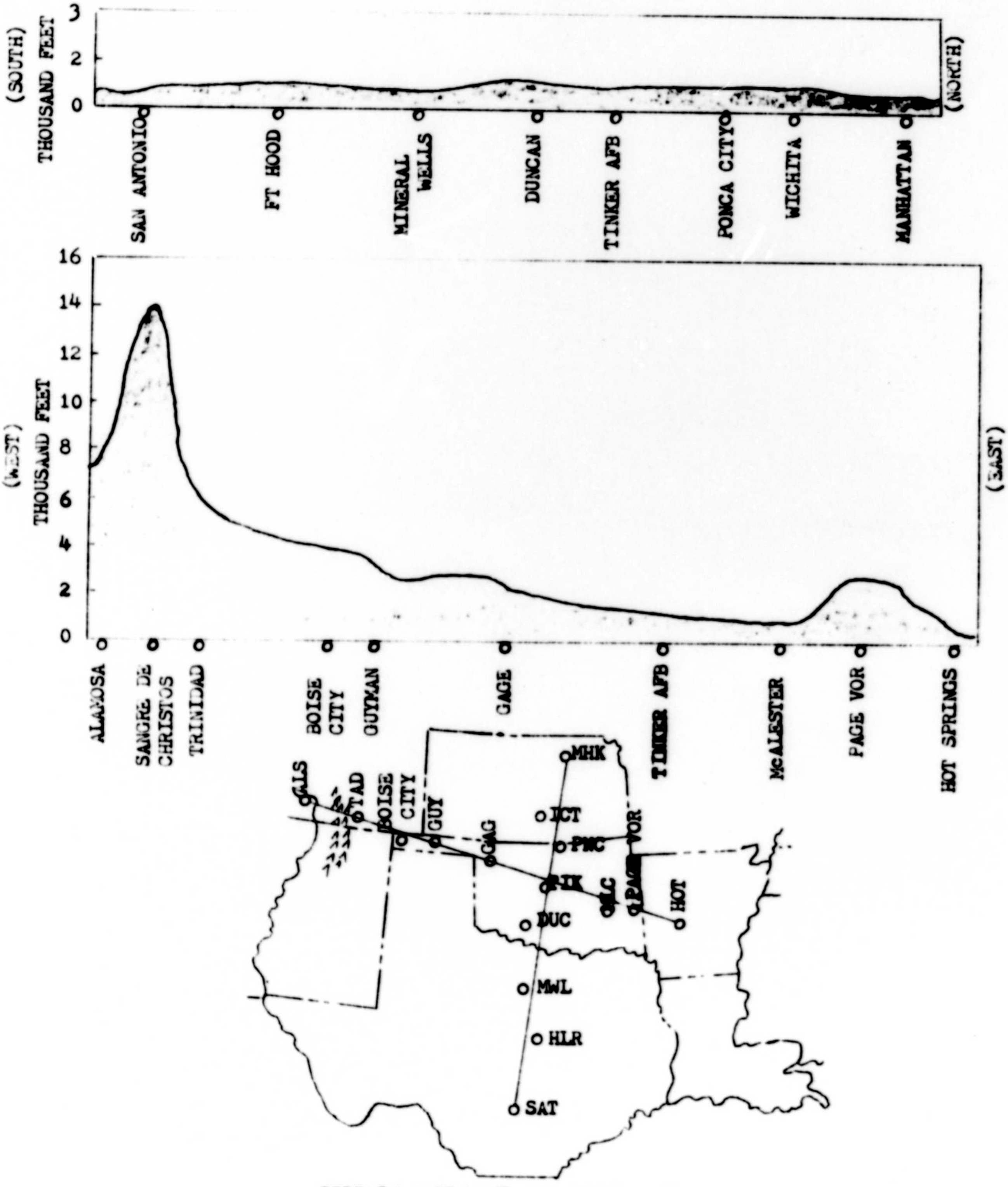
Figure 1-1

In the large-scale topography surrounding the base there is no significant change in the terrain to the north for some 2,000 miles, or to northern Canada. To the south, the same topography and elevation persist for approximately 400 miles, or to the region of San Antonio, Texas. About 150 miles southeast in the Red River Valley, the terrain drops below 500 feet to the Gulf Coastal Plain. To the west, the terrain elevation increases to slightly above 5,000 feet in 400 miles to the base of the Rocky Mountains (Figure 1-2). This slope is gradual except for a rise of some 1,000 feet in 50 miles in the Texas Panhandle, where east facing bluffs of 500 feet or more separate the "Caprock" from the plains.

In summary, Tinker might be thought of as situated on a huge plain, 2,000 miles from its northern boundary, 400 miles from its western boundary, 150 miles from its eastern, and 400 miles from its southern boundary. This plain is tilted upward to the west with its western boundary being about 5,000 feet and its eastern boundary some 500 feet above sea level. There is no tilt to the north-south axis of this plane.

The natural vegetation of the area surrounding Tinker is grasslands except to the southeast, where scrub stands of southern hardwoods begin almost immediately, increasing with distance and the lower elevations through the east and southeast quadrants.

The combined factors of uninterrupted terrain and grasslands to the north and west offer no resistance to outbreaks of polar air from western Canada and from the Great Basin. The Great Plains are unique in the respect of offering perfect drainage with no resistance to polar air masses.



TERRAIN EAST-WEST AND NORTH-SOUTH

Figure 1-2

The first drainage resistance is encountered by polar air masses in the Interior Highlands region, which begins some 100 miles east of Tinker.

An important element in forecasting at Tinker AFB is the fact that the Great Plains, or grasslands, are to the north, west, and south and have become the predominant wheat growing area of the United States. This land is tilled and has little vegetation for a large part of the year, and in previous drought years became known as the "Dust Bowl." Below normal precipitation in this area during the fall, winter, and early spring seasons makes this terminal vulnerable to dust storms with visibilities reduced in locally raised blowing dust or settling dust raised on some occasions hundreds of miles from Tinker during the windy months of February, March, and April.

The nearest point of the Gulf of Mexico is 380 miles to the south-southeast from Tinker. Only SSW to SE winds can bring moist Gulf air directly to Tinker. Since the terrain upslope is gradual, and south-east is a prevailing wind direction, orographic effect is frequently a factor in forecasting. SSW winds are slightly downslope, but can still advect thin stratus cloud into this area for short periods.

The other water bodies in this area are: North Fork of the Canadian River flowing generally east about 5 miles north of the station; the South Fork of the Canadian flows southeast from about 18 miles south of the station. During winter months, fog may form over local lakes to the south (Draper Lake predominately) and be advected into Tinker with a south wind.

No air pollution problems from smoke sources outside the Tinker complex are encountered, as all heating is done with natural gas in this area and oil refinery and factory smoke are negligible. A very localized problem is occasionally encountered on base due to extensive testing of jet engines.

2. Weather Station Instrumentation

Figure 1-1 shows the large scale surroundings of Tinker Air Force Base. Figure 1-3 shows the detailed location of weather station facilities and illustrates the exposure of instruments. Notations on Figure 1-3 point out each item as follows:

a. The Forecast Section

(1) Location - ground floor, middle section of hangar, Building #240. The forecasters do not have a window to the outside. The view from the south side entrance to the hangar is open to the south and generally to the east and southwest. The view from the north entrance is entirely blocked to the west by a hangar, Building #230, and to the north by other buildings, seriously limiting the range of vision.

(2) Instrumentation - the forecast section is equipped with an ID-815 wind speed and direction indicator and a ML-563 barograph. The adjacent observer section has a ML-512 barometer. The radar room is located behind the forecast counter and contains the AN/CPS-9 storm detection radar console with the CEICON modification. A polaroid camera is installed on the radar console.

(3) Communications - the forecast section has a hotline telephone to the Control Tower and RAPCON. The forecast section may also receive incoming long distance calls by private telephone for off-base pilot briefings. A class "A" base phone, with an extension in the radar console room, is also available for local calls.

Two automatic answering telephones are used to provide forecasts to personnel on base. The observer serving the forecast section is in direct contact with the observer at the Representative Observation Site (ROS) by hotline telephone. The forecast section has a send telautograph for dissemination to ROS, Base Operations, Control Tower, RAPCON, and several locations supporting OCAMA. A telautograph receiver is used to receive weather data directly from the ROS. The forecast section is also equipped with a PFSV radio with an additional transmit-receive capability at the radar console.

b. The Antenna Tower and Modulator Room for the AN/CPS-9 storm detection radar. Located at the northwest corner of Building #230.

c. Representative Observation Site

(1) Location - abandoned control tower on the roof of Building #3102, 4300 feet south and 800 feet east of end of runway 17 and 1700 feet north and 800 feet east of end of runway 35. This site is considered to be representative in every respect except height above ground. The site is 88 feet above ground level instead of the ideal height of 15 feet. There are no restrictions to vision in any runway approach zone and only very limited close-in restrictions due to warehouses, hangars, etc.

(2) Instrumentation - the site is equipped with a ML-563 barograph, ML-102 barometer, indicators for the AN/GMQ-11 temperature-humidity set, a wind speed and direction recorder RO-362 of the AN/GMQ-20 wind system, a rain gauge, and an Active Runway Indicator with capability for switching the active sensor of the AN/GMQ-10 and AN/GMQ-13 dual instrument installation.

(3) Communications - a telautograph transmitter located here permits the observer to disseminate his observations directly to the Base Weather Station, Base Operations, Control Tower, RAPCON, and several locations supporting OCAMA. Hotline telephones are also available to the observer serving the forecaster at the Base Weather Station and Control Tower. A class "A" base phone is also installed.

d. The Runway 17 AN/GMQ-13, Cloud Height Set, is located 800 feet north of the end of runway and has a 400-foot base line.

e. The Runway 17 AN/GMQ-10, Visibility Measuring Set, receiver is located 240 feet east of taxiway "A" and approximately 800 feet south of the end of Runway 17. The projector is located 501 feet 10 inches south of the runway.

f. The Runway 17 AN/GMQ-20 Wind Transmitter, is located 150 feet east of taxiway "A" and approximately 1,200 feet south of the end of Runway 17 on a 13-foot mast.

g. The Runway 35 AN/GMQ-13, Cloud Height Set, is located 3,350 feet south of the end of Runway 35 in the middle marker annex and has a base line of 400 feet.

h. The Runway 35 AN/GMQ-10, Visibility Measuring Set, projector is located 1,104 feet west of the center line and 800 feet north of the end of Runway 35. The receiver is located 501 feet 10 inches north of the projector.

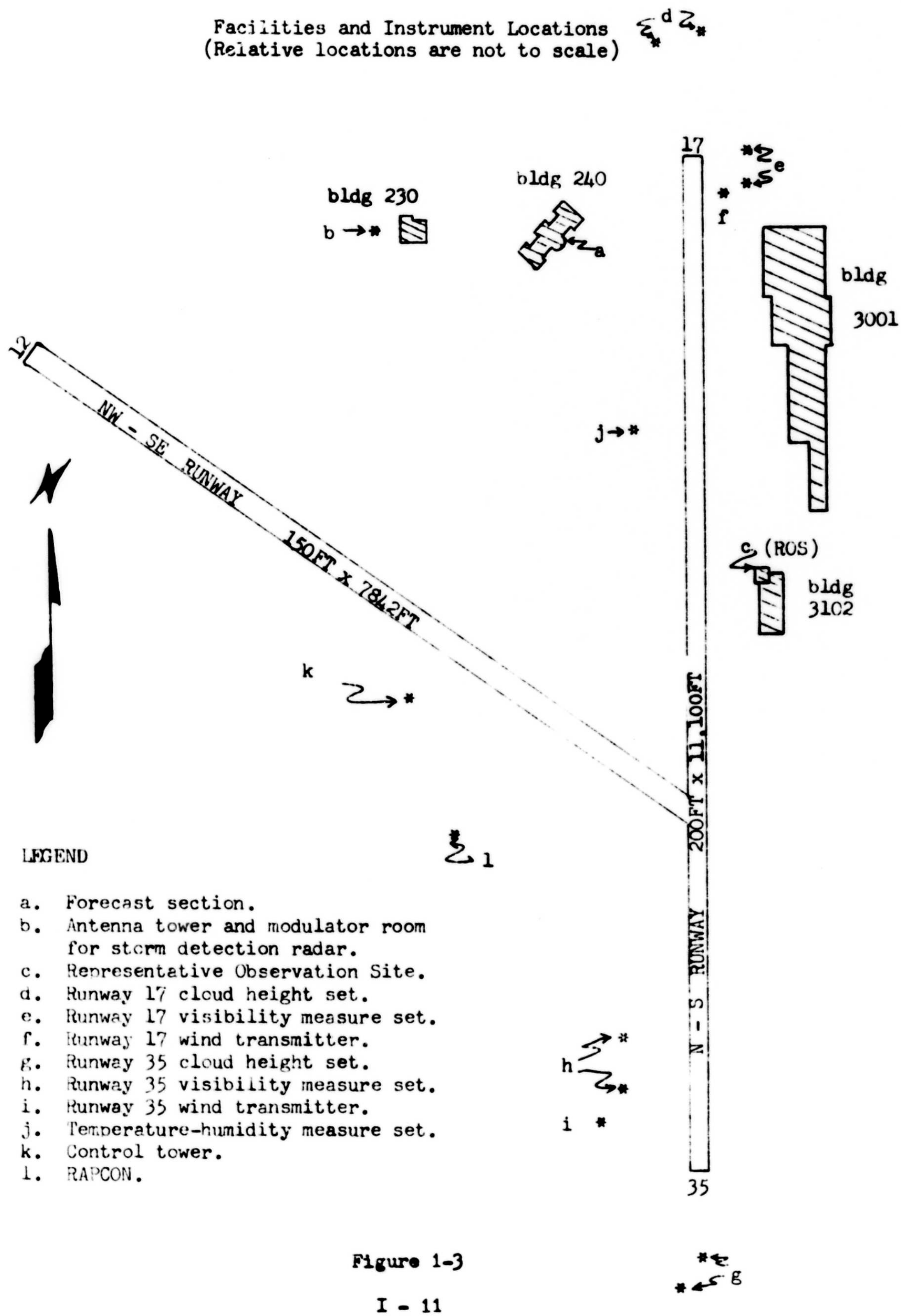
i. The Runway 35 AN/GMQ-20, Wind Transmitter, is located 1,127 feet west of center line and 750 feet north from the end of Runway 35 on a 13-foot mast.

j. The AN/TMQ-11, Temperature-Humidity Measuring Set, is located in a grassy area 250 feet east of taxiway 11 and 1,250 feet north of taxiway 3.

k. The Control Tower is equipped with an ID-373, Wind Speed and Direction Indicator. It also has a receive only telautograph from the ROS and the Base Weather Station. A hotline telephone is available to the ROS and the Base Weather Station. The Control Tower operator has the capability to switch the wind sensors from one end of the runway to the other.

l. RAPCON has two (2) ID-373, Wind Speed and Direction Indicators installed. It also has a hotline telephone to the Base Weather Station. A receive only telautograph is available to obtain data from the ROS and the Base Weather Station.

Facilities and Instrument Locations
(Relative locations are not to scale)



LEGEND

a. Forecast section.
b. Antenna tower and modulator room for storm detection radar.
c. Representative Observation Site.
d. Runway 17 cloud height set.
e. Runway 17 visibility measure set.
f. Runway 17 wind transmitter.
g. Runway 35 cloud height set.
h. Runway 35 visibility measure set.
i. Runway 35 wind transmitter.
j. Temperature-humidity measure set.
k. Control tower.
l. RAPCON.

Figure 1-3

S E C T I O N II

WEATHER CONTROLS

TINKER AIR FORCE BASE, OKLAHOMA

1. Major Synoptic Features

The most persistent air mass over this area is of tropical origin. During the summer and early fall when the Bermuda Ridge has the most pronounced development over the Southeastern United States, and the southwest thermal low is present, a large proportion of the winds at Tinker are from the southern quadrant. In June, for example, these amount to 78%. When the south winds have a westerly component, the air usually tends to be dry and fair weather prevails. On the other hand, when the surface wind has an easterly component, moisture is readily brought over Tinker from the Gulf of Mexico, and the dew point spread decreases. In the spring and early summer, the moisture from the Gulf maintains the squall line zones through Texas and Oklahoma. Approaching fronts and troughs then initiate prefrontal squall line thunderstorms in these zones. In the winter time, the influx of Gulf moisture and the upslope or overrunning with postfrontal fog or stratus are responsible for the low clouds and fog that persist in this area.

During the period from November to March, the mean Gulf surface water temperature is much warmer than the free air temperature over it. This means that air masses in their trajectory over the Gulf gain a higher relative humidity in these months. When they are borne inland on southerly winds over the cold land surfaces, they become stabilized, producing the overcast skies and fog, which in turn, account for the large amount of ceilings below 200 feet and/or visibility less than 1/2 mile (Figures 3-13 through 3-16).

It may be noted from graphs in Section III that most of the annual precipitation accumulates through the spring and summer seasons. This is also the thunderstorm period. During spring and summer, the approach of fronts, both polar maritime and continental types, serve to trigger the greatest amount of thunderstorm activity in the form of prefrontal squall lines. The greater portion of wintertime precipitation results from moist air masses overrunning a cold, slow moving continental air mass lying over the Great Plains. This moisture may come in from the south at low levels or from the southwest at the higher levels, or both. Moisture advected over Tinker from the southwest above 700 MB occurs when cyclonic systems develop west of 100 degrees and move in the tracks described. (See George, J. J., et al, "Further Studies on the Relation Between Upper Level Flow and Surface Meteorological Processes," Scientific Report No. 2, Eastern Air Lines, Inc., June 1954.)

Visibility at Tinker is generally good, averaging 10 miles or more 87% of the time. Radiation fogs are infrequent and of short duration since evaporation from the soil is weak at night because Tinker is in a dry subsoil region. Postfrontal fogs, however, occur in the winter months after the passage of slow moving cold fronts. The only other visibility restrictions, other than precipitation, are blowing sand and dust which occur during drought when strong winds in the so-called "dust bowl" stir up the dust to pollute an air mass which is subsequently advected into the Tinker Area.

Moisture in sufficient amount to produce precipitation in the local area comes from two sources: (1) low level from the Gulf of Mexico, and (2) high level from the Pacific.

Low level moisture is carried inland over Old Mexico up the Rio Grande into the Big Bend Area of Texas (Midland, Big Springs, Abilene) then northeast into Oklahoma. Reaching a depth of 8,000-10,000 feet, this moist layer will produce light precipitation if a trough aloft moves through. Normally, moist air and stratus that enter Texas east of Corpus Christi will seldom be thick enough to produce more than a brief, very light drizzle in Oklahoma. The exception will be when circulation is due to a low in western Texas rather than around the back side of a high east of us.

The second source of moisture is brought in at high altitudes from the Pacific, usually off southern California or Baja California. With the lifting provided by an active trough or low aloft moving through, several hours of light or even moderate precipitation may occur especially if a significant area of positive vorticity advection passes over Oklahoma. Initial cloud bases will remain 8,000 - 10,000 feet but with the increased low level moisture, succeedingly lower ceilings will form. With both low and high level moisture sources contributing, it follows that the potential for maximum cloud depth, precipitation and icing is present.

A review of the Northern Hemisphere Historical Weather Maps (NHHWM), 1948 through 1958, reveals frontal passages at Tinker with an average frequency as follows:

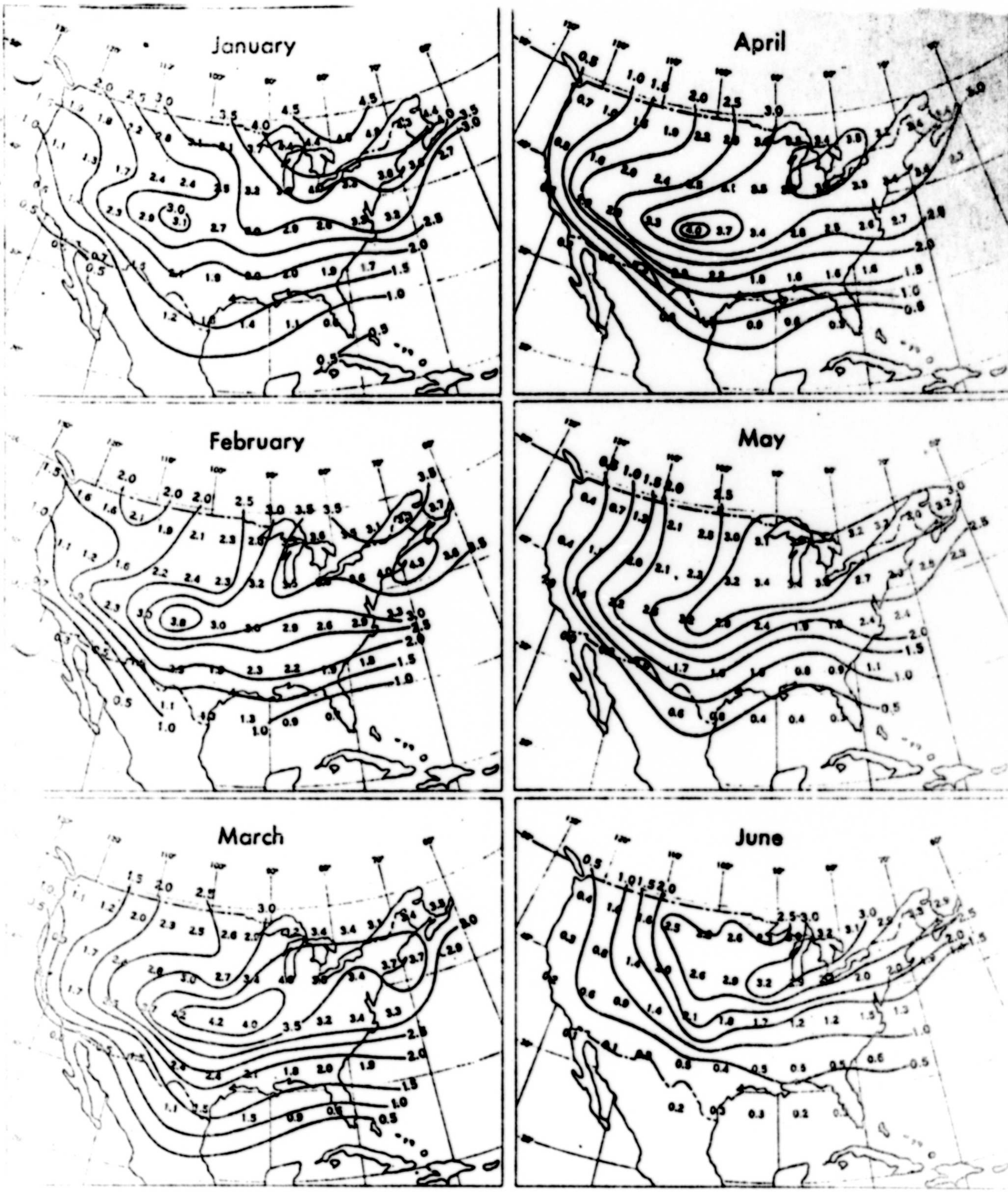
Frequencies of Frontal Passage

MONTH	CONTINENTAL POLAR COLD FRONT	MARITIME POLAR COLD FRONT *	MARITIME TROPICAL WARM FRONT
January	4.5	6.0	1.0
February	5.0	5.0	1.0
March	4.0	7.0	1.5
April	4.0	6.0	1.5
May	4.0	4.5	1.5
June	2.0	3.0	1.0
July	1.5	3.0	1.0
August	3.0	2.0	1.0
September	3.5	4.0	1.5
October	4.0	4.0	1.0
November	5.5	5.0	1.0
December	5.0	6.0	1.0
Annually	46.0	55.5	14.0

Cyclone frequencies may be noted from Figures 2-1a and 2-1b.

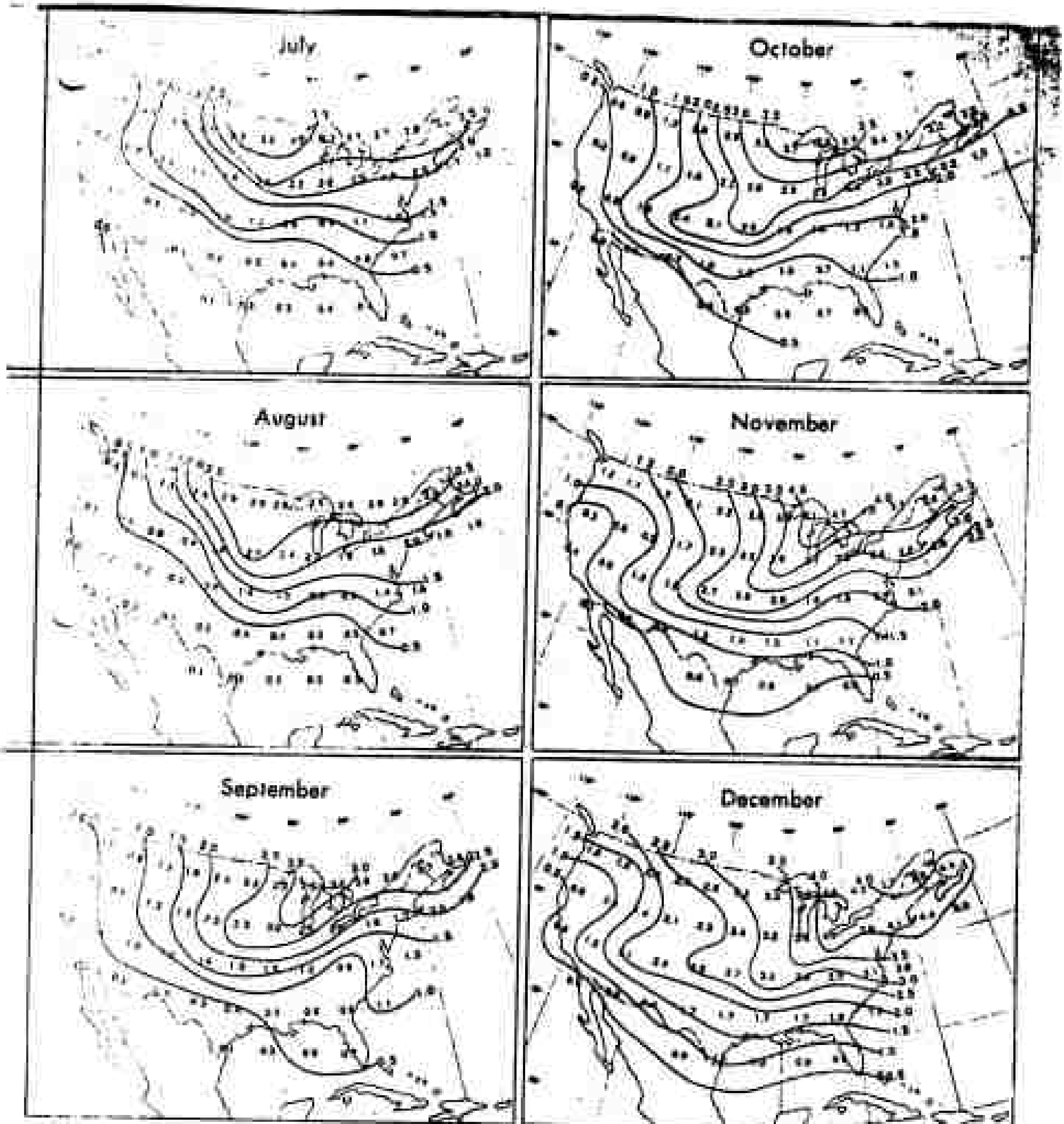
*The Maritime polar air masses are modified over the Rocky Mountains.

Table 2-1



Number of cyclones passing through each 5° latitude-longitude grid in the United States, by months, 1905-1954. (Klein, W.H.: "Principal Tracks and Mean Frequencies of Cyclones and Anticyclones in the Northern Hemisphere," U.S. Weather Bureau, Research Paper No 40.)

Figure 2-1a



Number of cyclones passing through each 5°latitude-longitude grid in the United States, by months, 1905-1954. (Klein, W.H.: "Principal Tracks and Mean Frequencies of Cyclones and Anticyclones in the Northern Hemisphere," U.S. Weather Bureau, Research Paper No 40.)

Figure 2-1b

2. <u>Winter Weather Controls</u>

Winter and spring comprise the bad weather seasons in Oklahoma. Cold frontal passages of both continental polar (cP) from Canada, and maritime polar (mP) air from the Pacific, occur frequently (Para 2, Page II-4). Inflow of the strongly contrasting warm, moist, tropical air (mT) often results in extremely active fronts between the polar and tropical air masses. Most often, when these two types of fronts pass here alternately, the mP air mass will move through first, followed by the cP air. However, if the arctic air mass reaches Tinker first, a potential exists for a heavy snowfall as the warm, moist southerly trajectory over-rides the cold dome of cP air in this area. The Canadian outbreaks, with reasonable 850mb cold air advection, tend to move at the speed of the 850mb wind flow during the night, then slow during the day. Possibly the cold air drainage from the mountain slopes is responsible for this acceleration at night. The diurnal variation is most pronounced on quasi-stationary fronts orientated east-west in the vicinity of Oklahoma.

The condition most conducive to producing low ceilings in the winter is a stationary front in southern Oklahoma. For example, return flow of warm, moist air following a cP outbreak brings wide areas of low stratus and fog. The returning warm, moist air overruns the wedge of cool, polar air and precipitation from the middle cloud deck aloft aids the formation of frontal fog and stratus. Moreover, the warm precipitation quickly transforms the shallow polar wedge into a moist air mass which rapidly becomes indistinguishable from the mT Gulf air.

This overrunning rain pattern creates an extremely hazardous condition; falling as it does into colder air, precipitation reaches the ground as sleet, freezing rain, or snow. The more lasting snow covers at Tinker have been a result of a coating of sleet or ice following the snowfall. This formation of overrunning fog and stratus and its spread northward result in conditions near landing minimums which have persisted for as long as 5 days at a time. Clearing usually is dependent upon the passage of a cold front, subsequent entrance of a polar air mass, and westerly winds.

Visibility almost invariably stays one or two categories higher than ceiling during the various weather situations at Tinker and when it is low, it is usually for only 2-4 hours at most. One exception, of course, is in radiation fog.

Warm frontogenesis can occur in the Oklahoma area in winter when surface temperatures are in the range 25 to 35F and a slow moving cyclone develops in the eastern Rocky Mountain Region. The south border of snow cover over the Oklahoma-Kansas Region, if also present, is an added factor favoring warm frontogenesis. (See George, J. J., etal, "Further Studies on the Relation Between Upper Level Flow and Surface Meteorological Processes," Scientific Report No. 2, Eastern Air Lines, Inc., June 1954.)

When maritime polar air masses come over the mountains from the west, normally, a warm type occlusion will stagnate in the mountains, while the upper cold front progresses unhindered to regenerate east of the Continental Divide. In late February and into spring, this system may become very active with thunderstorms, heavy showers, and often hail, when it encounters the maritime tropical air over Texas and Oklahoma.

Upper lows or troughs moving eastward out of southern California or from the southwestern states will cause early cloudiness in Oklahoma. Cirrus often will cover this area even before the low reaches New Mexico. A familiar upper air configuration is for a low to cut off and move southwest into southern California instead of continuing east. The essential steps noted in forecasting the cut-off low at 500mb are (1) shift to northerly wind at Seattle, Washington, and remain northerly, (2) a fall in 500mb temperature at Medford, Oregon, to -25C or lower, (3) a subsequent fall in 500mb temperature at Ely, Nevada, to -25C or lower, followed by a distinct temperature rise at Medford. The more easterly the winds become at Seattle, the farther south the low will be located. If the position of the low is in Arizona, or western New Mexico, more eastward movement can be expected. A low over southern California or off shore is persistently stationary.

3. Spring Weather Controls

In February, thunderstorms will begin occurring occasionally along the Gulf coast. Through the following weeks of spring and summer, the belt of maximum thunderstorm activity moves north, centering over Oklahoma in May and moving north into the central plains during the summer. Also, during this season, frontal activity which moved south of Oklahoma all winter, will now begin to stall in this area or just north. A typical springtime frontal behavior is a stationary cP front oriented southwest-northeast with a strong south-southeast flow of moist air overrunning a north-northeast flow of polar air over the Texas Panhandle, across Oklahoma, Kansas, and Missouri. Precipitation

is intense and prolonged north of the frontal system. Several days of poor weather often results as light rain and low stratus prevail and intermittent periods of thunderstorm activity accompany unstable waves along the frontal zone. To the south, in the warm air, broken cumulus with isolated light showers and 3,000 to 5,000 feet ceilings generally prevail. This frontal situation, occurring as it does following the spring thaw, produces flooding in the midwestern regions. In late spring, eastern Oklahoma and parts of the adjoining states receive more rainfall on the average than any other part of the country east of the Rockies. There is a decided tendency for squall lines to form in the warm air, oriented parallel to the stationary front through Texas. These squall lines can generate some of the most intense local storms that are produced anywhere in the world. The lines move rapidly eastward for 200 to 300 miles and then tend to dissipate. It is due to the above conditions that Tinker is included in "Tornado Alley."

Air mass thunderstorms are rarely a problem at Tinker and generally require a light winds aloft profile of less than 15-25 knots below 20,000 feet and less than 50 knots above. On the other hand, lifting due to fronts, troughs, and squall lines are frequent severe weather producers, especially when associated with a low level southerly jet and/or high level westerly jet.

A feature that influences thunderstorms and surface winds at Tinker is the low level jet. This jet may occur any time during the year, but maximum frequency is observed from roughly 15 May to 15 June and again 1 September to 15 November. The following conditions influence the formation of the low level

jet: (1) deepening leeside trough or low along the cap-rock in the area between Reese AFB, Texas, and Goodland, Kansas; (2) high pressure in lower Mississippi Valley (Arkansas, Tennessee, and Louisiana, usually a break-off high); (3) strong warm advection over Texas, Oklahoma, and Kansas; (4) low level inversion or tendency to form night time radiation inversion; and (5) pressure difference Amarillo, Texas-Tinker approximately 8mb.

The existence of the jet may first be observed by aircraft flying in the Dyess AFB, Texas-Tinker area. The jet max will occur near the top of the surface inversion (usually 4,000-5,000 feet), reach maximum speed around 0500-0600 CST, then diminish and extend to the surface as the inversion is broken by day-time heating. This type of jet, rather than being narrowly defined horizontally, is shaped more like a flat sheet with quite pronounced vertical definition, and spread out 100-200 miles in width.

Jet intensity is related to the stability of the air mass formed during afternoon heating. More unstable air above the inversion tends to strengthen the jet; 45-55 knots is common, with occasional 60 knots or more.

4. Summer Weather Controls

Tinker summer weather is dominated by the Bermuda High. Circulation is predominantly south-southeast and moist in the lowest 6,000 feet, becoming southwesterly and drier above 8,000 feet. Scattered cumulus form in the afternoon, but seldom mature into thunderstorms. Most thunderstorm activity is associated with passage of weak cold fronts. High level night thunderstorms occur infrequently, but the presence of a weak front to the south of Tinker and advection of cold air aloft are conditions favorable for occurrence.

The zone of nocturnal thunderstorms stays north of Oklahoma City, but a few occur every summer with a fairly deep mid level moisture profile (8,000-18,000-foot layer with less than 6C temperature—dew point spread) and potential mid level instability. Radiational cooling of 3C or less in the 12,000-18,000-foot layer should produce a moist adiabatic lapse rate or greater for favorable conditions. The favored onset time is after 0300 CST, reaching a peak at 0400-0500 CST, and the latest onset expected is 0700 CST, which is attributed to radiational cooling in the lower levels near the surface and subsequent absorption of heat at the base of Cb's, thus increasing instability. As a general rule, nocturnal thunderstorms will dissipate from 0800-1000 CST depending upon the area size of the activity. The greater the maximum horizontal extent during peak activity, the longer should be the expected duration. Activity less than 25 miles wide should end by 0800-0900 CST, while activity of more than 75 miles in width could be expected to last into the afternoon.

Oklahoma becomes a region of frontolysis for both mP and cP fronts in the summer. The fronts become stationary and dissipate very often in the southern part of the state in early June and late August, and in the northern part of the state in the middle of the summer season. In early summer and again in fall, cold fronts often stall in the Gage, Oklahoma, and Goodland, Kansas, areas during periods of maximum heating as pressures rise slowly south of the front. With the onset of radiational cooling, the front may move into Oklahoma, but presence of a cloud cover will reduce this tendency. Some forecasters have found that in the above situation in order to pass Tinker, a front must have a 5,000-foot wind speed at least 10 knots stronger in the cold air than in the warm air (normal to the front).

Summertime visibility is generally 7-12 miles, however, the visibility seldom exceeds 12-15 miles due to haze which is always present in the summer mT air—usually to an elevation of 6,000 feet. This haze becomes particularly bad when a cP cell stagnates over the midwest. In such a case, surface visibilities may be reported as 7-9 miles, while aloft they are 3-5 miles in a haze layer from 4,000-8,000 feet. Blowing dust and smoke are infrequent, but occasionally restrict surface visibility; not to the point of being a hazard. Occasionally a cell of superior air (dried by the subsidence off the southwestern plateau deserts) reaches the Tinker area and advances eastward. It will be accompanied by clear skies, extremely low humidity, and gusty, southerly surface winds that may raise blowing dust as the system moves eastward.

Fog is seldom a problem in the summer. It has been observed that in an otherwise early morning fog producing situation, temperatures of 70 degrees and above, or dew point of 65 degrees and above, usually preclude fog formation even though humidity may be 100%.

The only other significant summertime feature is the beginning of the hurricane season. Records show instances about every year during late summer and during the fall when tropical storms or hurricanes from the Gulf of Mexico or the Gulf of California recurve in a manner to bring an extensive cloud cover over Oklahoma. Generally, little precipitation occurs from these situations, but a notable exception was effected by hurricane "Carla" during mid-September 1961.

5. Fall Weather Controls

The mT circulation of the Bermuda High generally moves southeastward at this time of year and mP and cP pushes become more numerous. Light ground fog and stratus become more prevalent in the mornings, while frontal passages become increasingly more of a forecast problem. By mid-October, or early November, mid-latitude type weather again extends south into Oklahoma. Forecasters should be alert to the increased influence of short wave troughs aloft. Use the vorticity chart to spot short waves that may have positive vorticity advection ahead of them. Ceilings can drop to 500-1,000 feet in steady light rain for 4-6 hours with a trough aloft that, a month earlier, would have produced only middle cloud.

A passing early winter storm may leave the ground wet and the skies clear to night time radiation. With cooler air mass and wet ground, fog will likely form around sunrise and burn off late morning. One exception will be if surface to 5,000-foot winds become westerly and surface wind stays above 3 knots.

By late fall, two stratus situations increasingly become forecasting problems. These are due to cold frontal passages, and southeasterly winds from the Gulf. Winds behind a cold front may be northeast giving upslope flow. Any wind direction 010 clockwise through 190 degrees, given sufficient moisture upstream, poses the threat of a stratus ceiling at Tinker. When sufficient moisture is present to produce stratus behind a southward moving cold front, chances are good that Tinker will observe stratus ceilings for a few hours after frontal passage. If 2,000-foot winds, and below, are upslope, the stratus may not dissipate, depending upon the time of day. If stratus dissipates during the day and winds remain upslope, ceilings will likely re-form again between midnight and sunrise depending upon the amount of moisture and cooling. With early morning stratus north northeast through east, pay close attention to winds aloft at stratus level in eastern Oklahoma for a possible "backdoor" occurrence. Not always, but usually the Tinker area stays clear in these cases where low level winds are north northeast to northwest and the cloud shield moves southeast.

Any trough aloft in westerly flow crossing the southern Rockies will induce a surface trough east of the Rockies. The resulting surface pressure field will set up south to southeast surface winds in the southern plains to the Gulf coast and advect Gulf moisture upslope to Tinker. With middle clouds still aloft, the stratus will break, not with the frontal passage, but usually with the 700mb trough passage. As the post-frontal surface high moves east, the return flow south and southwest of the high may again advect Gulf moisture into southern Texas and northward. With no cloud above, this stratus burns off every day, as will be the case if it reaches Tinker. However, with middle cloud or a cirrus

ceiling reducing day-time insolation, burn off may not occur.

The average date of the first frost is November 6 at Tinker, but the first freeze has occurred as early as October 7. Snow and freezing precipitation do not usually pose much of a flight hazard during this season. Very few cases of snowfall have ever been recorded at Tinker during the month of October, and only about every other year does snow occur at Tinker during November.

An increase in pressure gradient in the southern plains is reflected in stronger surface winds and associated low level turbulence. The direction of the wind is still south southeast a majority of the time, but the presence of northerly components increase with the increase of mP and cP frontal passages.

S E C T I O N   III

CLIMATIC AIDS

TINKER AIR FORCE BASE, OKLAHOMA

Oklahoma Tornado Season

Tornadoes have occurred in all months of the year, but according to climatology, 74% were reported in April, May, and June. May is the month of maximum tornado frequency.

From 1875 through 1966, a total of 1,467 tornadoes was reported in Oklahoma resulting in 1,076 fatalities. One of the largest tornadoes in Oklahoma, and most severe in terms of human life, moved across Ellis and Woodward Counties on 9 April 1947. Its path of destruction measured one to two miles in width as it crossed portions of the Texas Panhandle, western Oklahoma, and Kansas. This huge storm hit the city of Woodward and caused considerable damage. Along its course in Oklahoma, 101 persons lost their lives, while 782 were injured.

The greatest property damage caused by a single storm in this state was on 20 March 1948, when Tinker Air Force Base was struck causing ten and a quarter million dollars damage. The following is copied from USWB records of two separate tornadoes which struck Tinker on 20 and 25 March 1948:
"Time: 10:10 p.m.—10:22 p.m.; Width of path—880 yards; Killed—0; Injured—8; Property damage—$10,250,000.
This storm apparently traveled about 10 miles in 12 minutes from Will Rogers Field to Tinker Field, leaving a path of shattered signs and damaged buildings. At Will Rogers Field, damage was estimated at $6,000 to planes and $3,000 to hangars, etc. A 98 mph wind reported at the Weather Bureau site there; a vertical barograph trace indicated pressure changed from 28.53 to 28.11 inches in a few minutes. As the storm approached Tinker, apparently two tornadoes

within the storm followed parallel paths. Fifty aircraft were destroyed and 50 others were damaged. Damage was estimated at $10,000,000 to aircraft, $222,000 to buildings, and $15,000 to utility systems. Several buildings east and north of Tinker were damaged or destroyed. From Tinker east, two paths could be traced; one northeast to vicinity 23rd Street, the other was limited to the southeast corner of Tinker Field and the immediate area northeast. The storm was accompanied by hail; there were eight injuries, mostly slight.

Time: 6:00 p.m.; Length of path - 1 1/2 miles; Width of path - 200 yards. Killed—0; Injured--1; Property damage—$6,100,000.
The second tornado to strike Tinker within a week, 84 planes were hit by the wind, 35 damaged beyond repair. This storm, accompanied by moderate hail (1/2 to 3/4 inches), apparently formed when two thunderstorms converged about 3 miles southwest of the field; one storm from the west, the other from the south southwest. Maximum wind recorded was 78 mph at the edge of the storm."

Oklahoma and Kansas have received the greatest number of tornadoes per unit area as illustrated by figure 3-4. Indeed, Tinker Air Force Base and the Oklahoma City area are found to straddle the famed "Tornado Alley" of the Midwest.

TOTAL NUMBER OF TORNADOES REPORTED IN OKLAHOMA,
BY MONTH, 1875 THROUGH 1967

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Number	22	33	104	339	556	234	75	45	43	24	36	5	1516
Percent	1.5	2.2	6.9	22.3	36.7	15.4	4.9	3.0	2.8	1.6	2.4	0.3	100

Table 3-1

Tornadoes are usually observed as a funnel-shaped cloud spinning rapidly and extending toward the earth from the base of a cumulonimbus type cloud. They may occur at any hour of the day or night, but because of the conditions which create them, they form most readily during the warmest hours of the day. The greatest number (82 percent) occurs between noon and midnight, with peak activity 1600-1800 CST.

Tornadoes most often move to the northeast and average 30 mph. Extreme speeds are zero and 68 mph. Path length averages 10 to 40 miles, but at least one storm was tracked and identified over a distance of nearly 300 miles. The path of destruction averages 250-400 yards wide and, as in the Woodward Storm mentioned above, can extend its destructive width to more than a mile.

The destructive features of a tornado are winds and violent pressure change. The rotary winds in the funnel are estimated over 300 mph and are capable of displacing automobiles and parts of houses in terms of hundreds of feet. The partial vacuum in the center of the funnel is capable of literally exploding a building due to the sudden pressure gradient created between the inside and outside of the building.

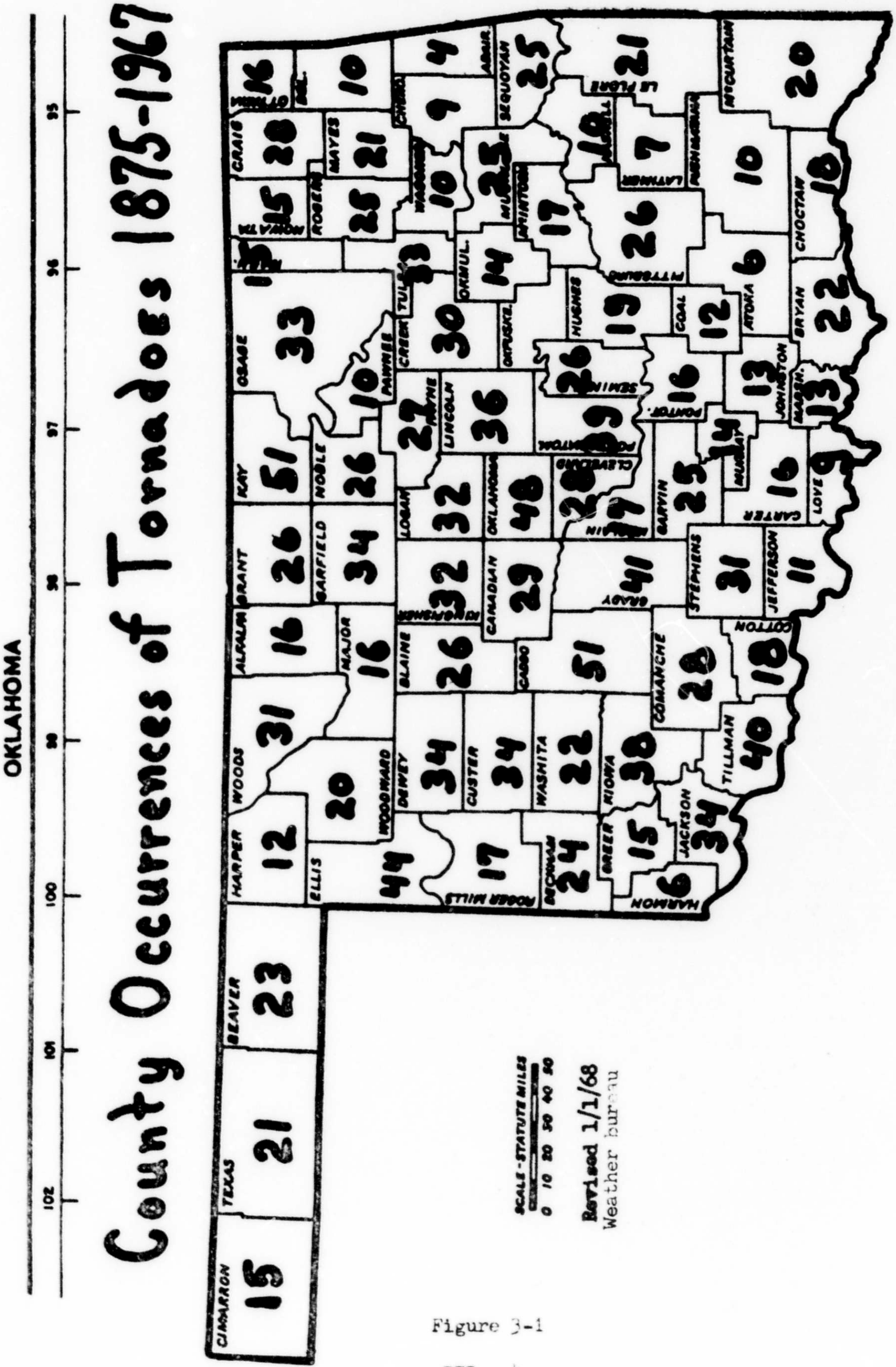
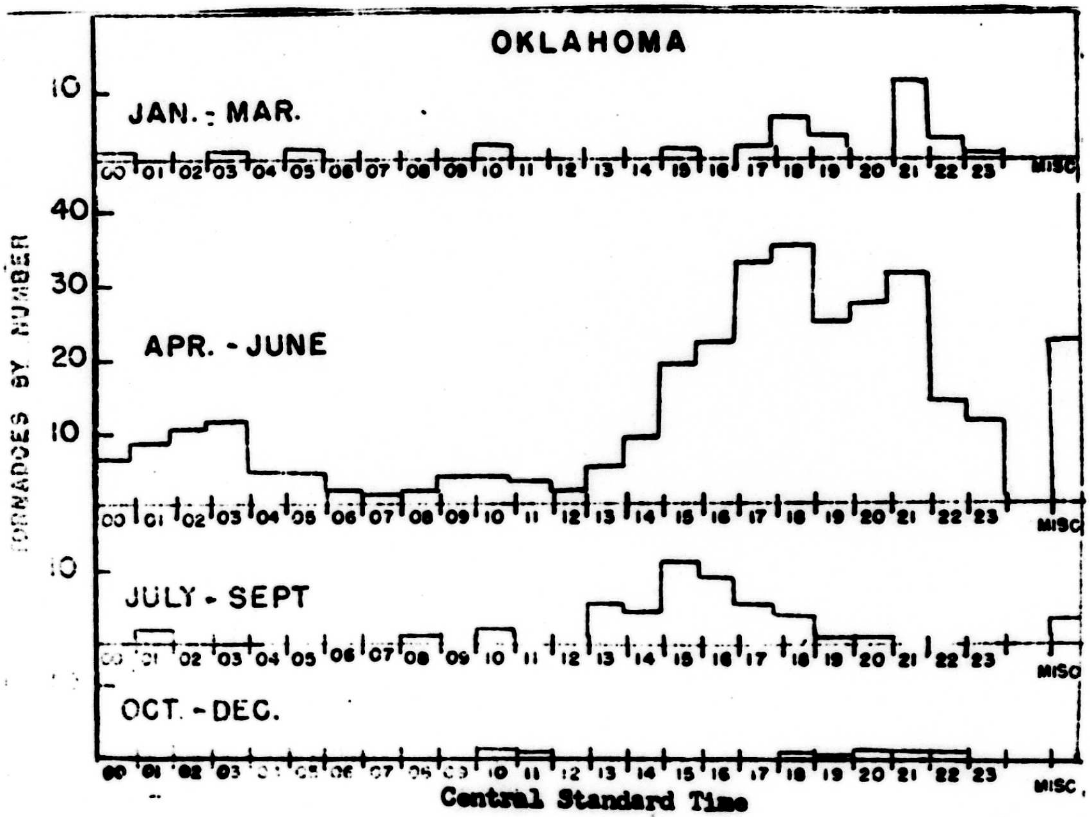
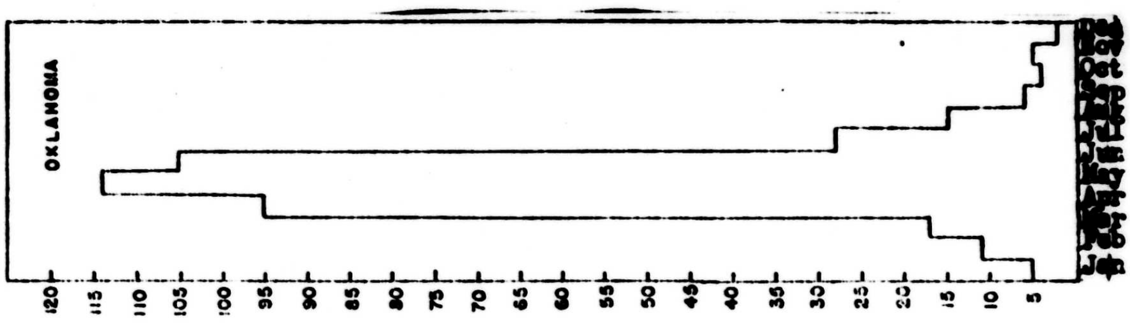

County Occurrences of Tornadoes 1875-1967
OKLAHOMA
95
96
97
98
99
100
101
102
CIMARRON 15
TEXAS 21
BEAVER 23
HARPER 12
ELLIS 44
WOODS 31
WOODWARD 20
ALFALFA 16
MAJOR 16
GRANT 26
GARFIELD 34
KAY 51
NOBLE 26
OSAGE 33
PAWNEE 10
DEWEY 34
CUSTER 34
ROGER MILLS 17
BECKHAM 24
WASHITA 22
BLAINE 26
KINGFISHER 32
CANADIAN 29
LOGAN 32
OKLAHOMA 48
LINCOLN 36
PAYNE 27
CREEK 30
TULSA 33
CADDO 51
GRADY 41
KIOWA 38
GREER 15
HARMON 6
JACKSON 34
TILLMAN 40
COMANCHE 28
COTTON 18
STEPHENS 31
JEFFERSON 11
CARTER 16
LOVE 9
GARVIN 25
MURRAY 14
CLEVELAND
McCLAIN
POTTAWATOMIE 39
SEMINOLE 26
PONTOTOC 16
JOHNSTON 13
MARSH. 13
BRYAN 22
COAL 12
ATOKA 6
CHOCTAW 18
HUGHES 19
OKFUSKEE
OKMULGEE 14
McINTOSH 17
PITTSBURG 26
LATIMER 7
PUSHMATAHA 10
McCURTAIN 20
LE FLORE 21
HASKELL 19
SEQUOYAH 25
MUSKOGEE 25
WAGONER 10
CHEROKEE 9
ADAIR 4
DELAWARE 10
MAYES 21
ROGERS 25
CRAIG 28
NOWATA 15
OTTAWA 16
WASHINGTON 15
SCALE - STATUTE MILES
0 10 20 30 40 50
Revised 1/1/68
Weather bureau

Figure 3-1

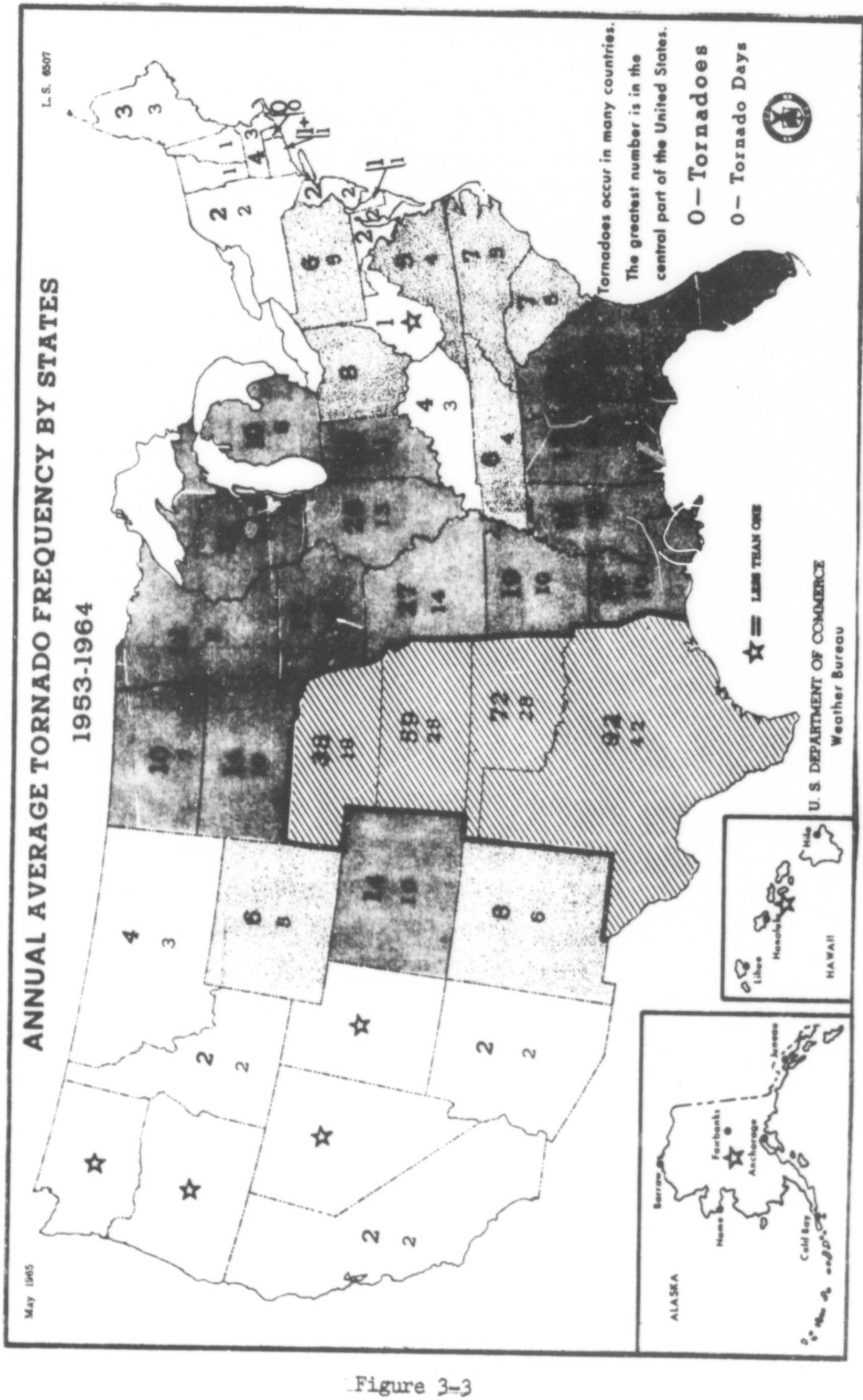




TOTAL NUMBER TORNADOES 1950 - 1956

From, (Monthly Weather Review, June 1958, United States Dept, of Commerce, Weather Bureau, Lee, J.T. : "Tornadoes in the United States, 1950 -1956.)

Figure 3-2



ANNUAL AVERAGE TORNADO FREQUENCY BY STATES
1953-1964
Tornadoes occur in many countries.
The greatest number is in the
central part of the United States.
0— Tornadoes
0— Tornado Days
☆ = LESS THAN ONE
U.S. DEPARTMENT OF COMMERCE
Weather Bureau
May 1965
L.S. 6507
ALASKA
Barrow
Nome
Fairbanks
Anchorage
Juneau
Cold Bay
HAWAII
Lihue
Honolulu
Hilo

Figure 3-3

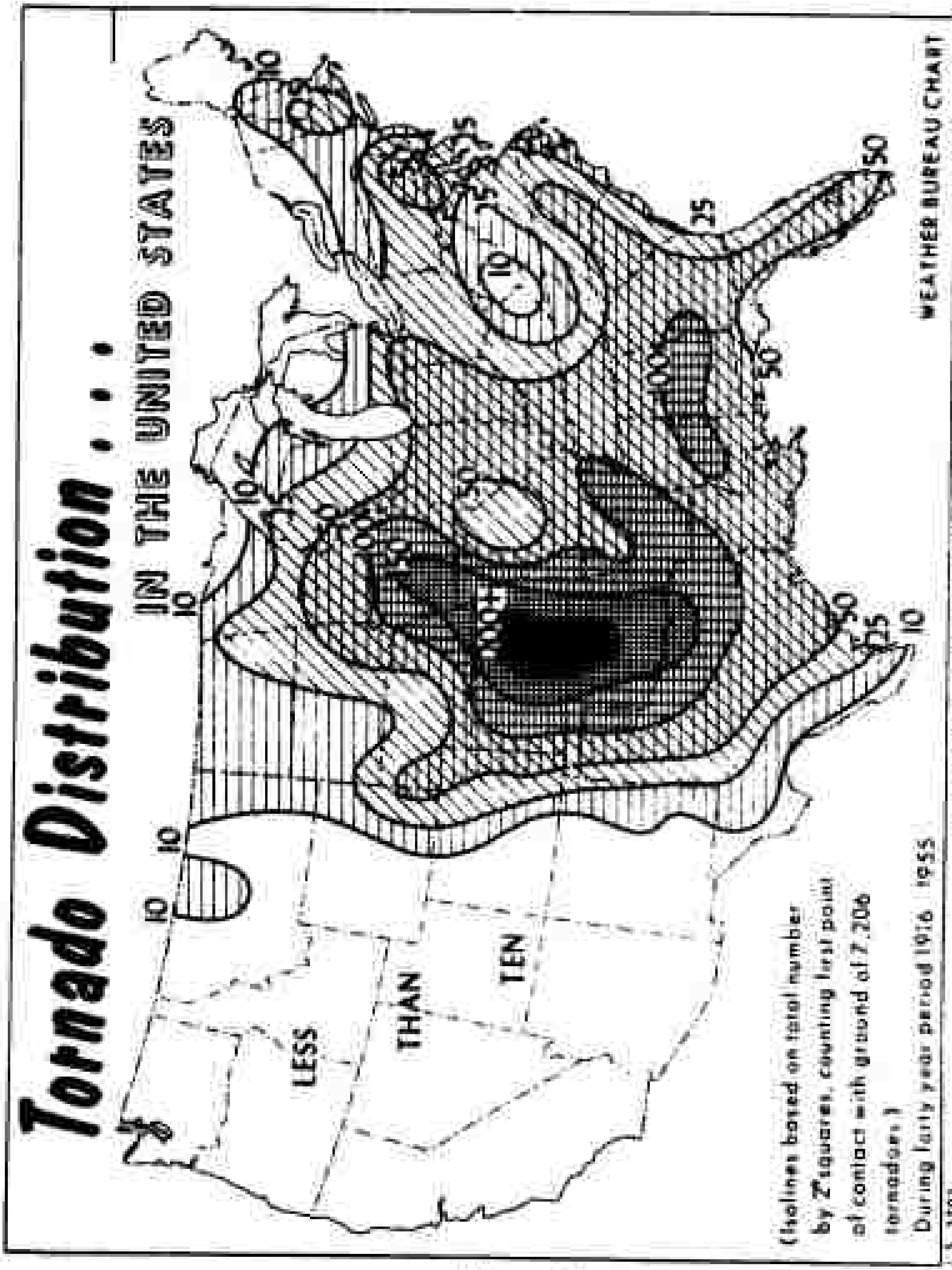
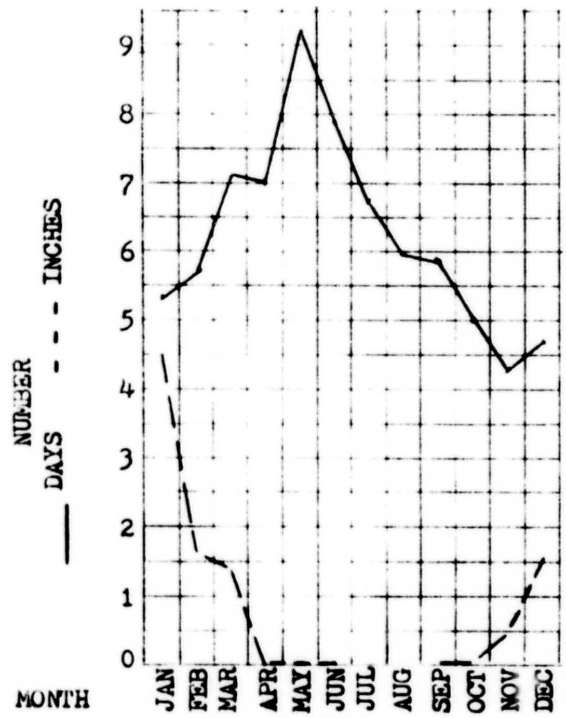
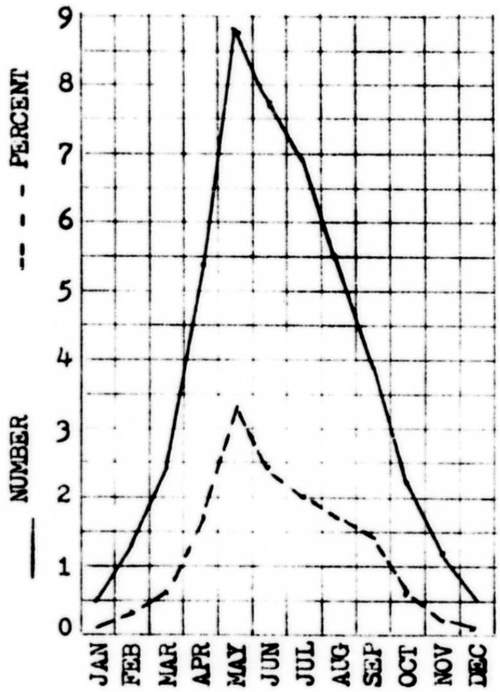

Tornado Distribution . . .
IN THE UNITED STATES
LESS
THAN
TEN
(Isolines based on total number
by 2° squares, counting first point
of contact with ground of 7,206
tornadoes.)
During forty year period 1916 1955
WEATHER BUREAU CHART
U.S. DEPARTMENT OF COMMERCE WEATHER BUREAU
10
25
50
100

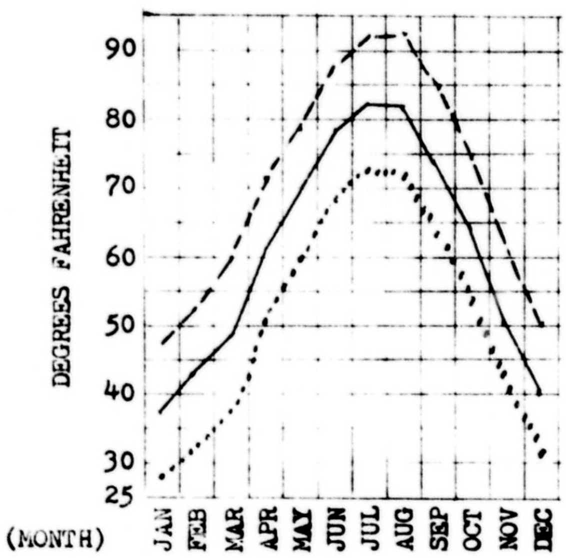
Figure 3-4





_____ Mean number of days with measurable precipitation.
- - - Mean snowfall in inches.

_____ Mean number of days with thunderstorms.
- - - Percentage frequency of occurrence, thunderstorms.



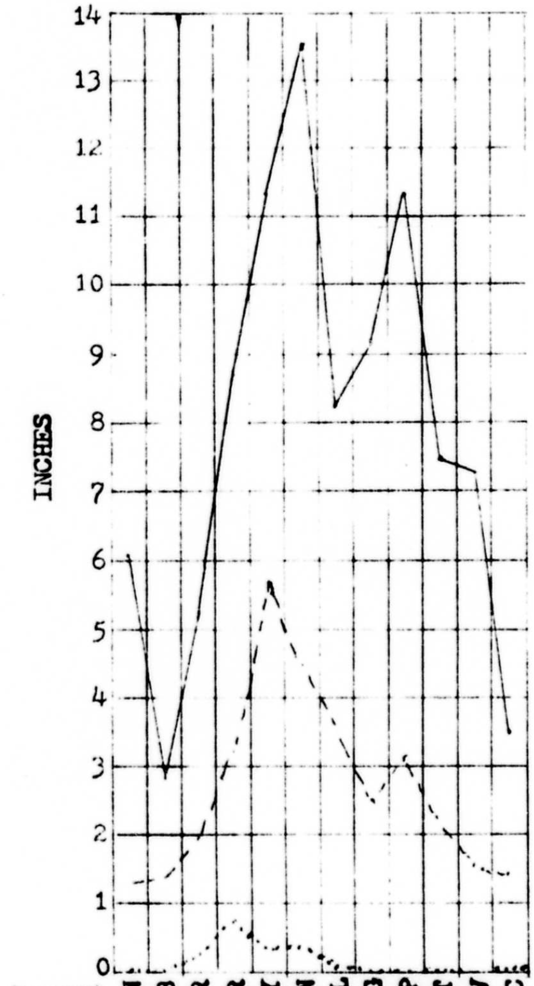
- - - -Mean maximum temperature.
_____ Mean temperature.
.......Mean minimum temperature.

(MONTH)	YEAR	DEG. (F)	YEAR	DEG. (F)
JAN	1911	83	1892	-11
FEB	1911	90	1899	-17
MAR	1907	97	1948	-3
APR	1925	96	1957	20
MAY	1939	99	1954	32
JUN	1936	107	1917	46
JUL	1943	109	1915	55
AUG	1936	113	1915	49
SEP	1947	107	1912	35
OCT	1951	98	1917	16
NOV	1891	87	1894	9
DEC	1955	86	1924	-2

*Extreme temperatures are from (USWB) records 1890-1942, and (TAFB) records 1943-1969.

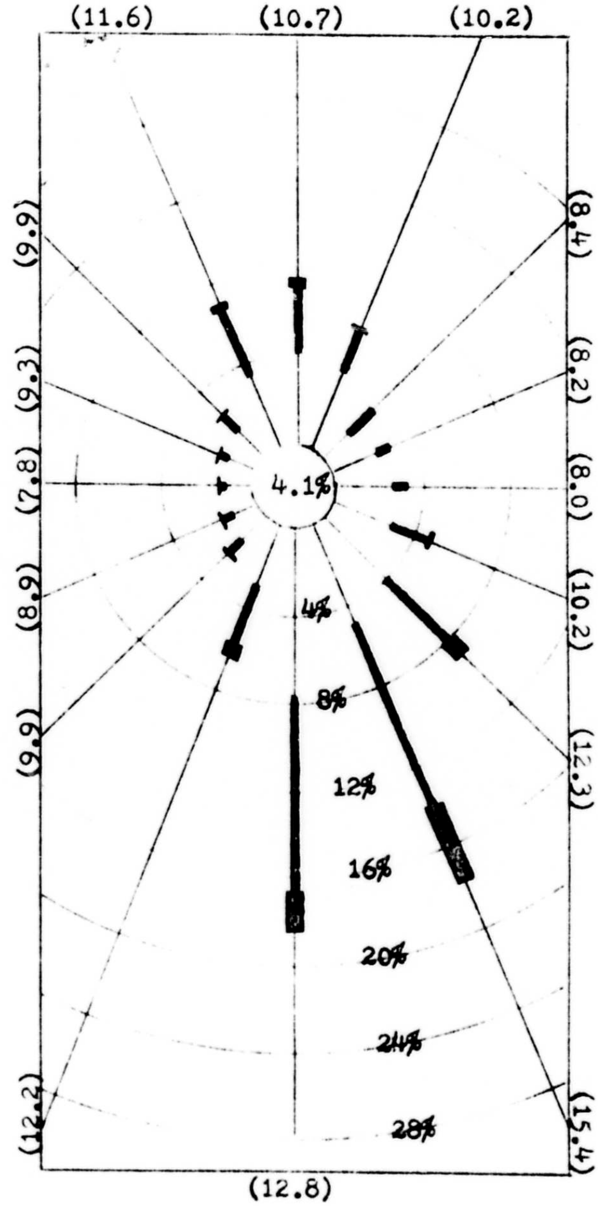
Precipitation data from Part "B" and Temperature data from Part "E", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Sep 66, Nov-Dec 66, Thunderstorm data from Part "A", for the period Jan 43-Jan 46, Sept 46-Nov 67. *

Figure 3-5

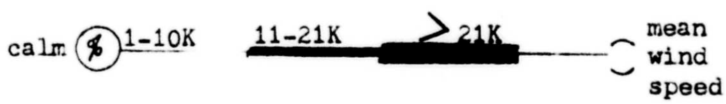


______ Maximum precipitation inches.
- - - -Mean precipitation inches.
.......Minimum precipitation inches.

(MEAN ANNUAL PRECIPITATION, 32.33 INCHES)

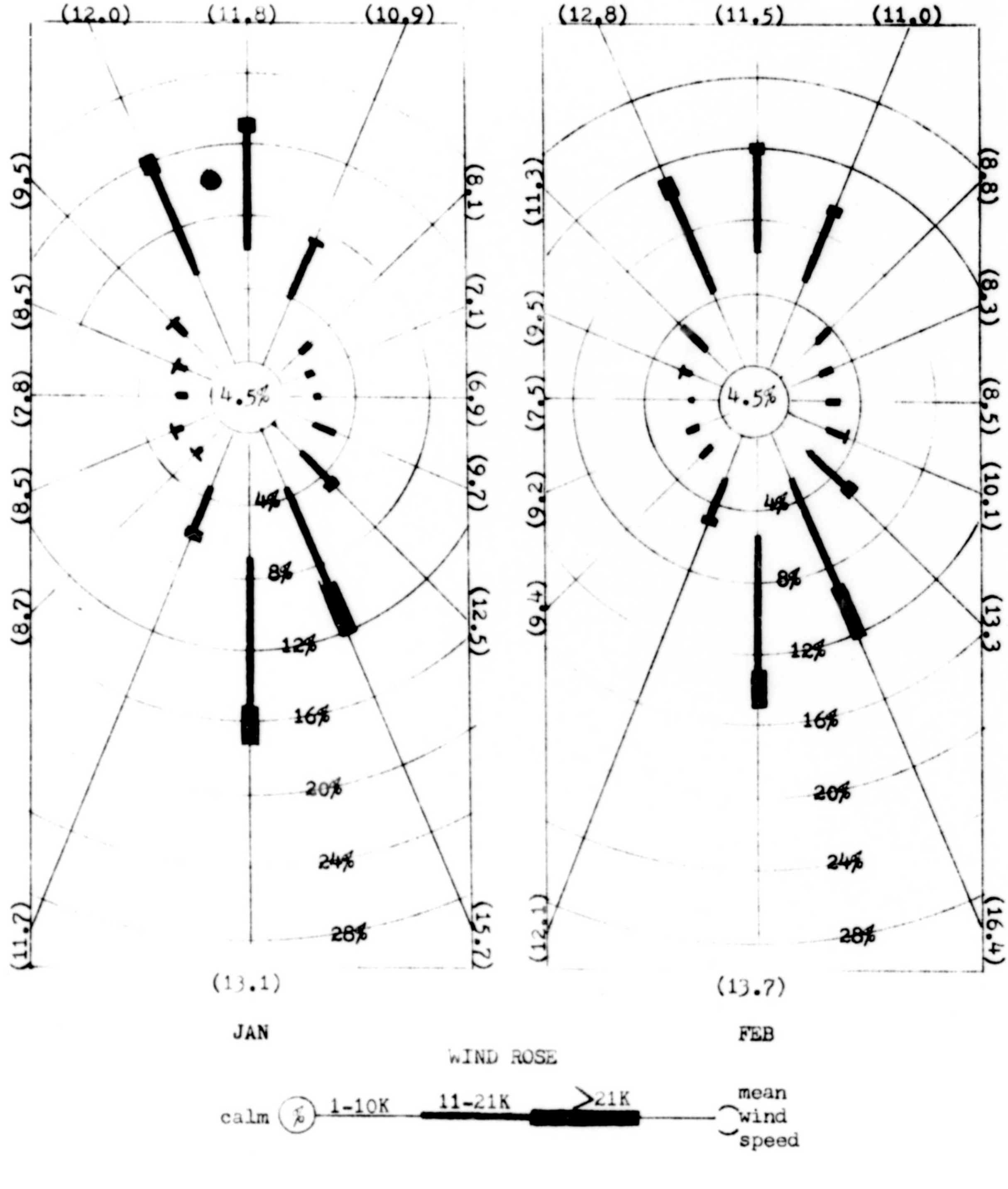


ANNUAL WIND ROSE



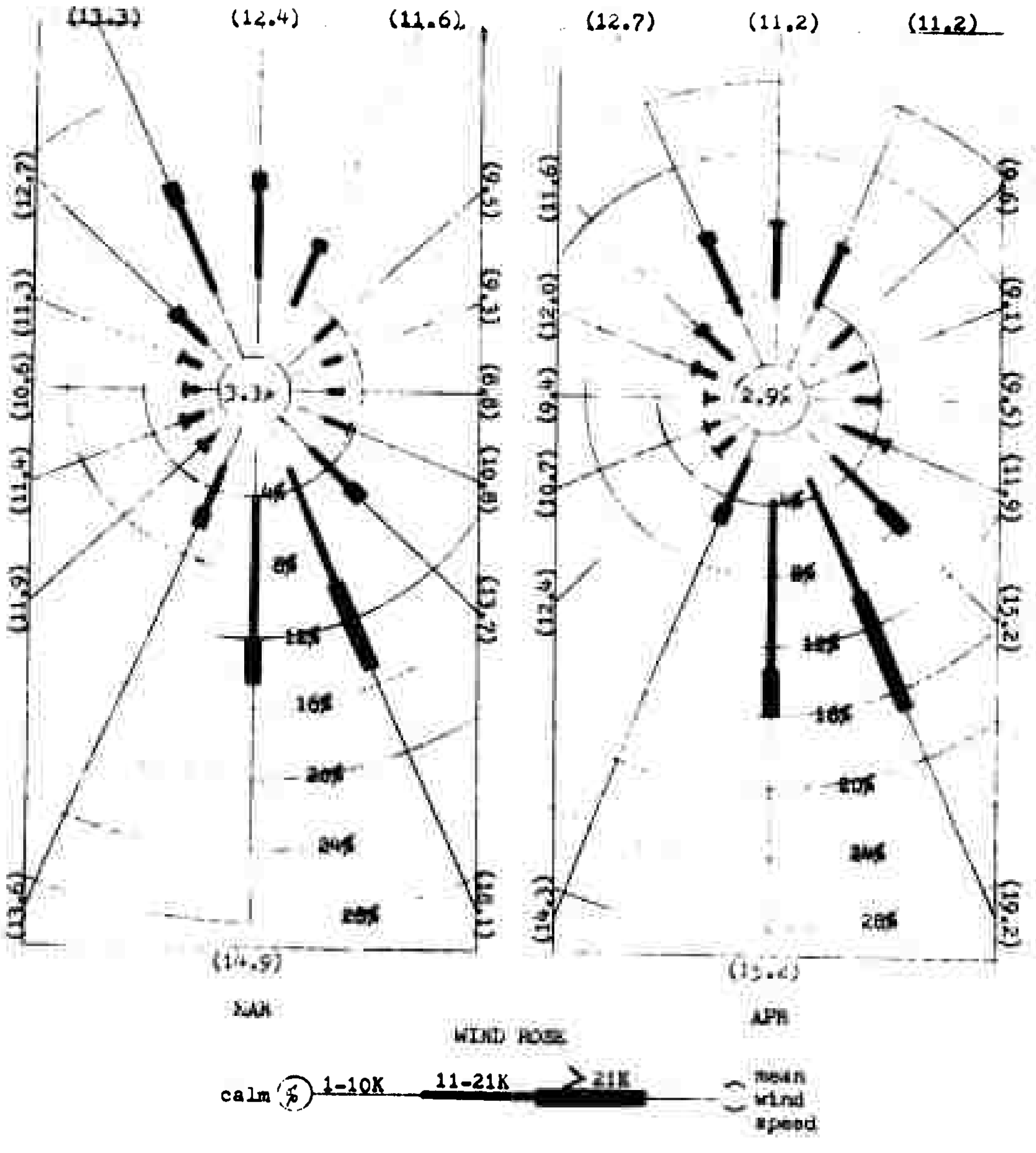
Precipitation data from Part "B", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Sep 66, Nov-Dec 66, Wind data from Part "C", for the period Jan 43-Jan 46, Sept 46-Nov 67.

Figure 3-6



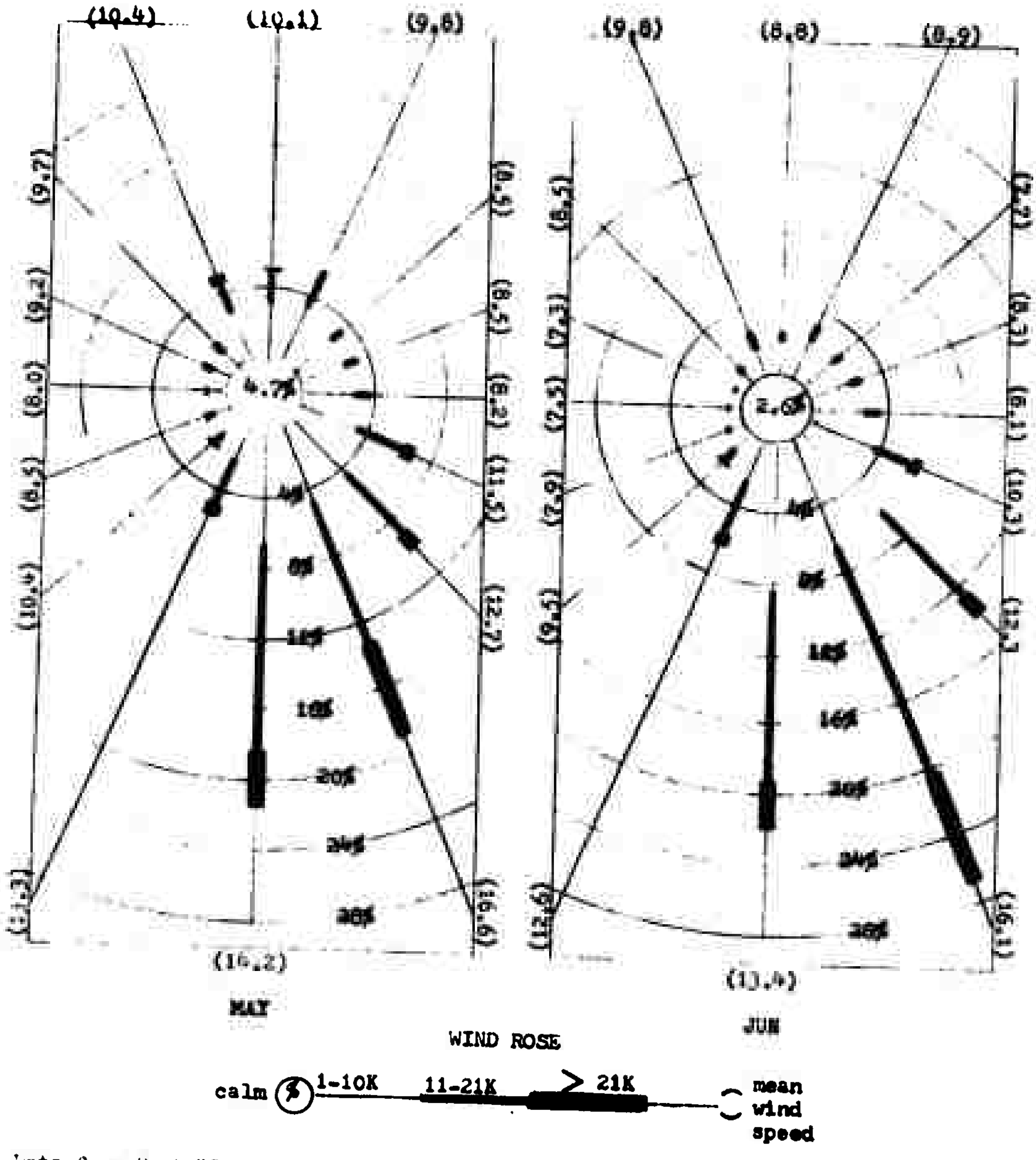
Data from Part "C", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Nov 67.

Figure 3-7



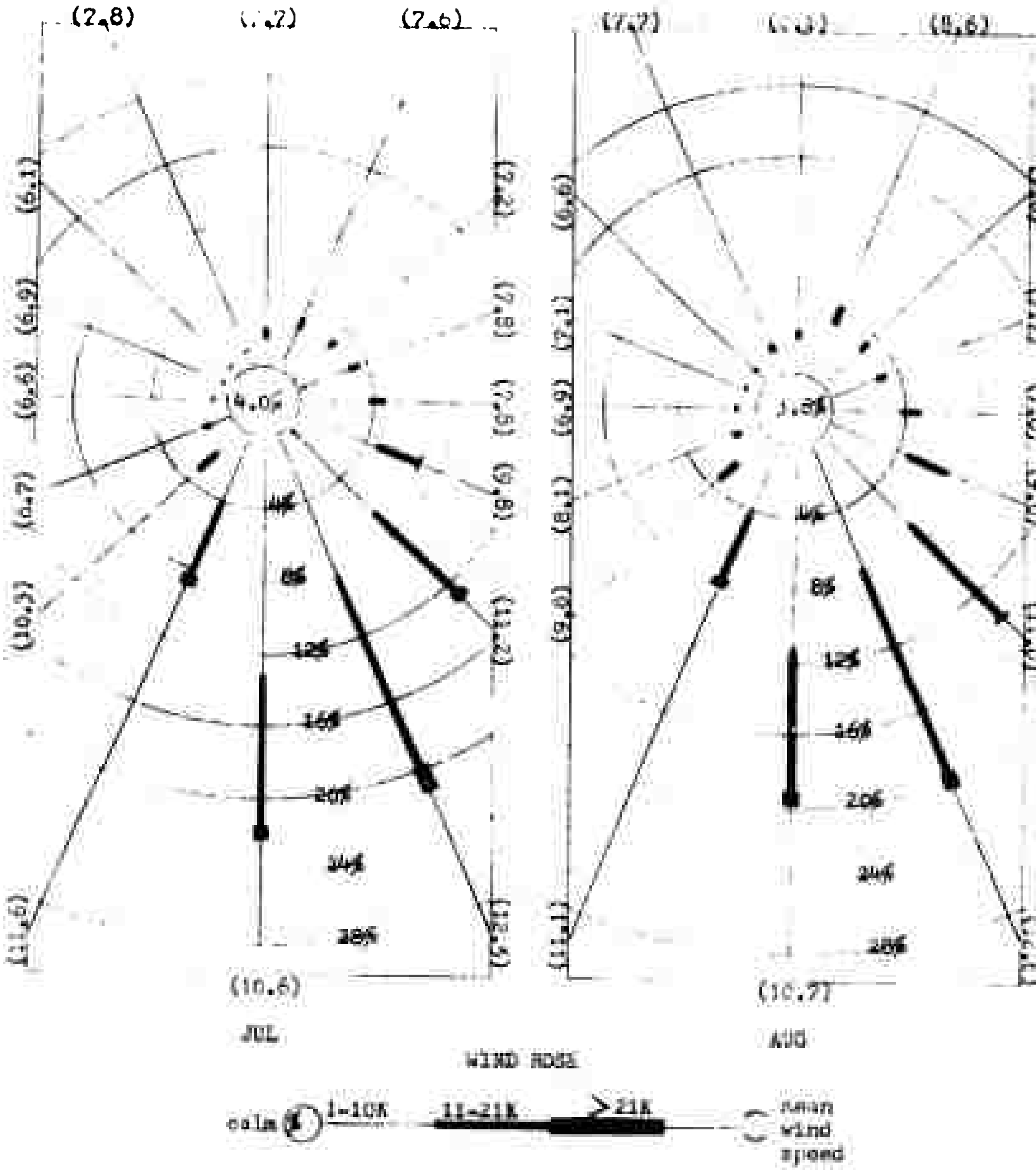
Data from Part "C", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Nov 67.

Figure 3-8



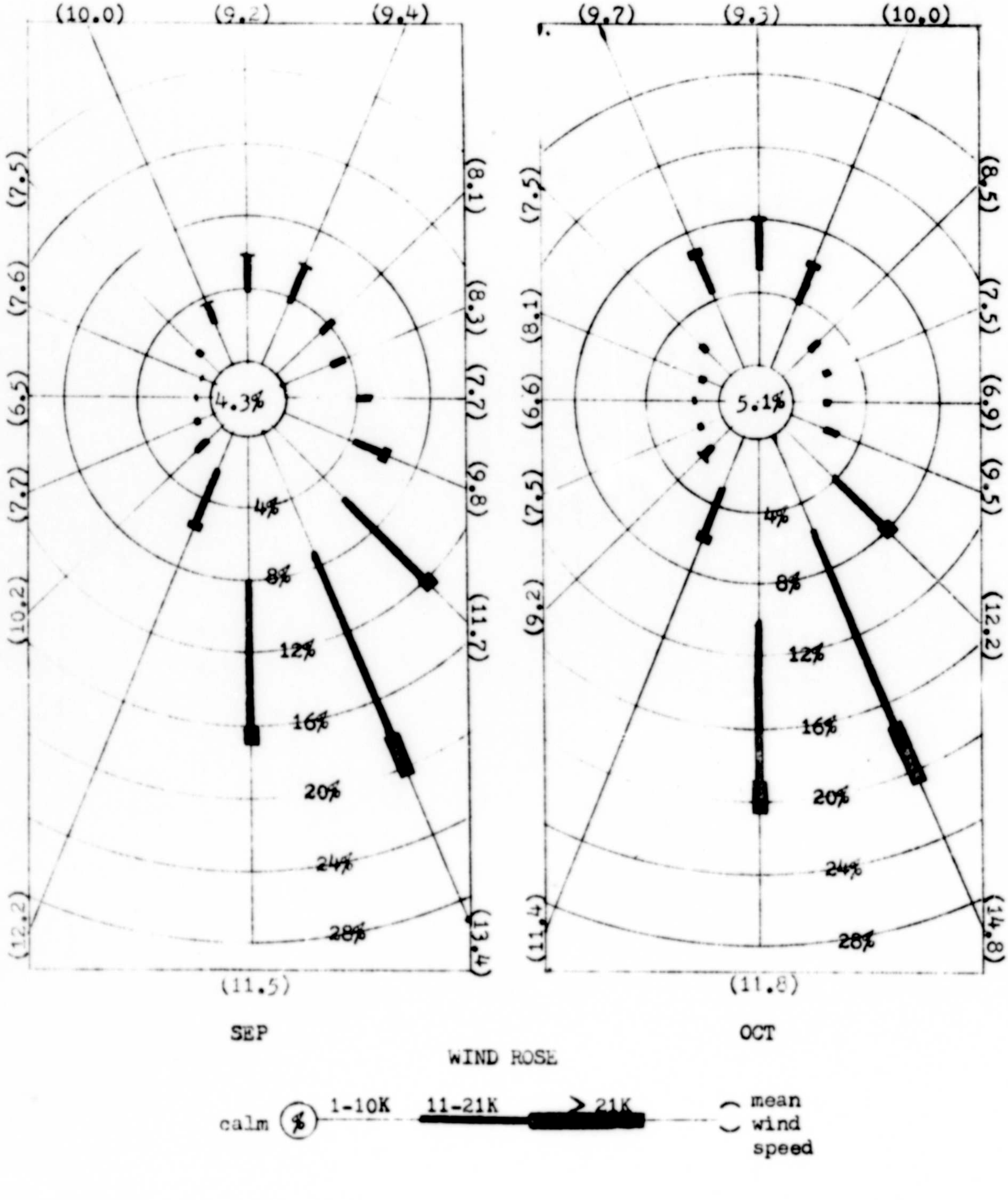
Data from Part "C", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Nov 67.

Figure 3-9



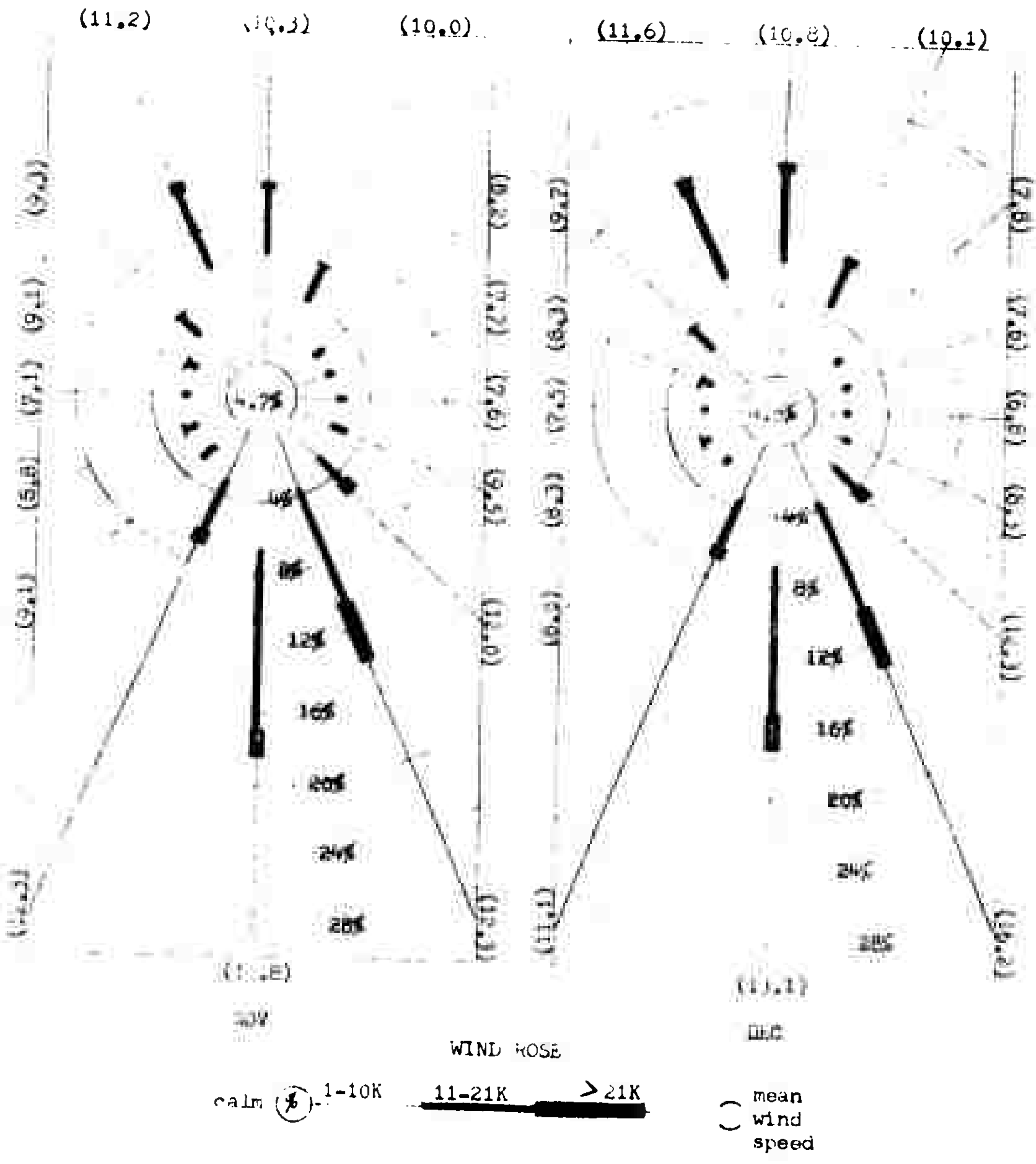
Data from Part "C", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Nov 67.

Figure 3-10



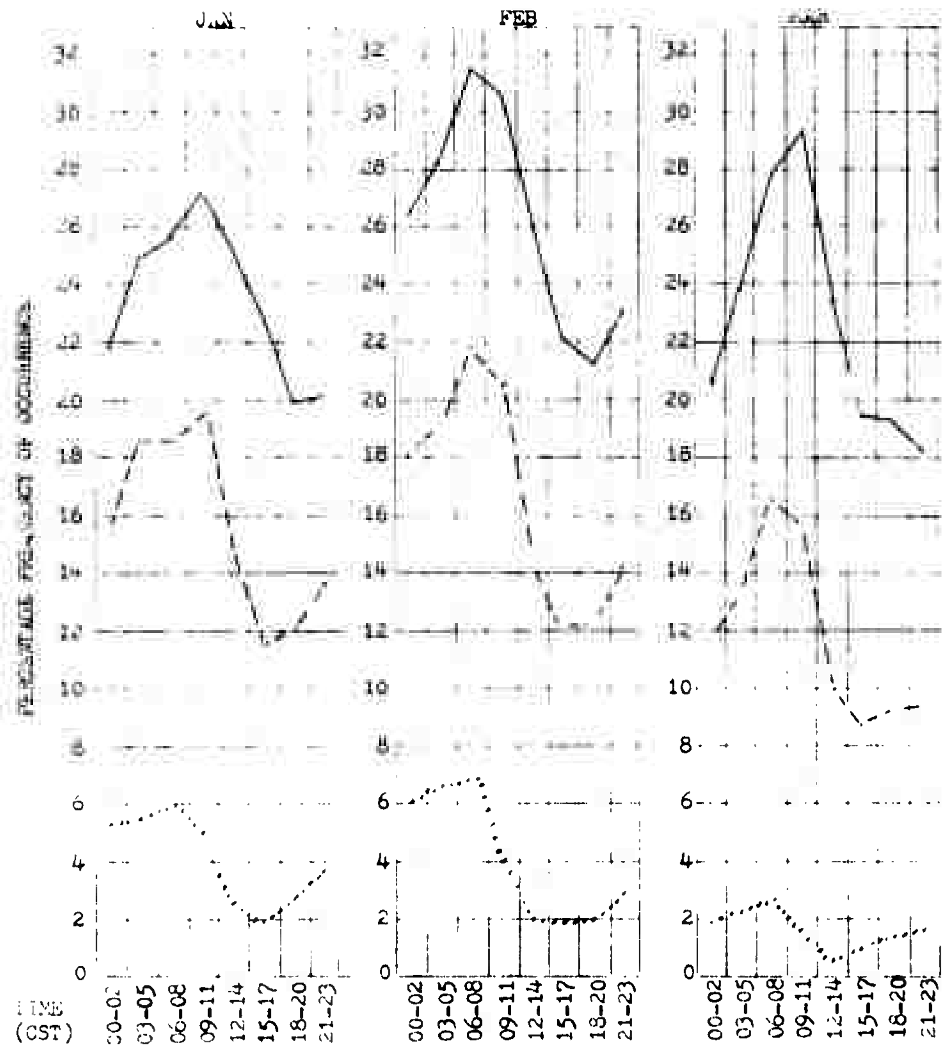
Data from Part "C", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Nov 67.

Figure 3-11



Data from Part "C", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Nov 67.

Figure 3-12

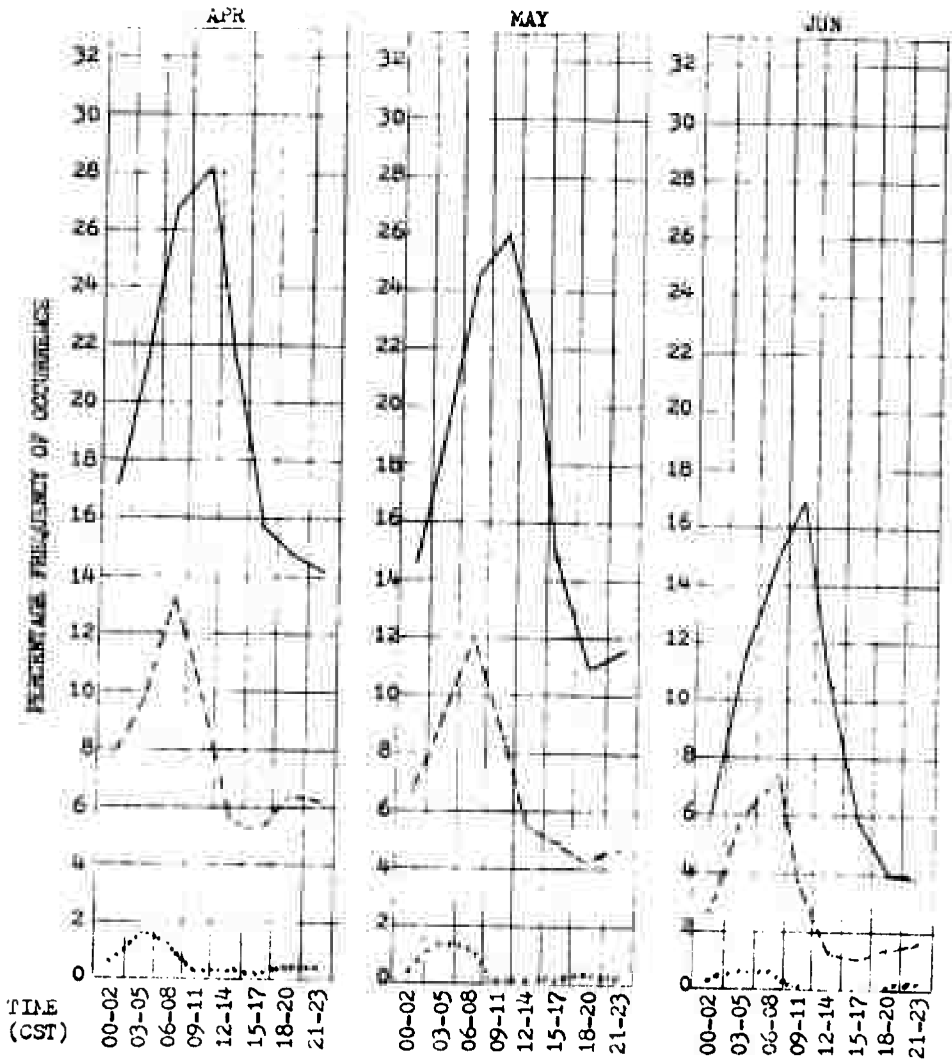


______ Ceiling less than 3,000 feet and/or visibility less than 3 miles.
--- -- Ceiling less than 1,000 feet and/or visibility less than 3 miles.
...... Ceiling less than 200 feet and/or visibility less than ½ mile.

CEILING VERSUS VISIBILITY

Data from Part "D", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Nov 67.

Figure 3-13

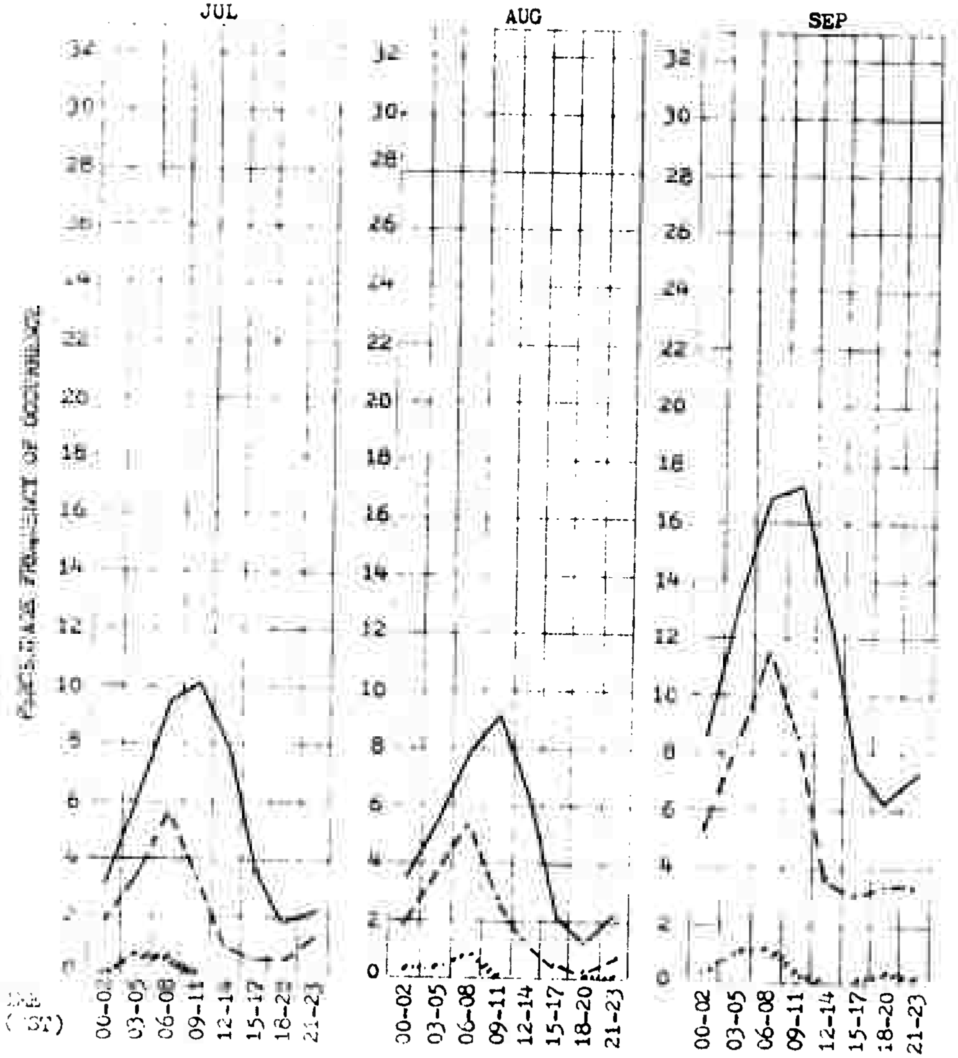


_____ Ceiling less than 3,000 feet and/or visibility less than 3 miles.
- - - - Ceiling less than 1,000 feet and/or visibility less than 3 miles.
······· Ceiling less than 200 feet and/or visibility less than 1/2 mile.

CEILING VERSUS VISIBILITY

Data from Part "D", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Nov 67.

Figure 3-14

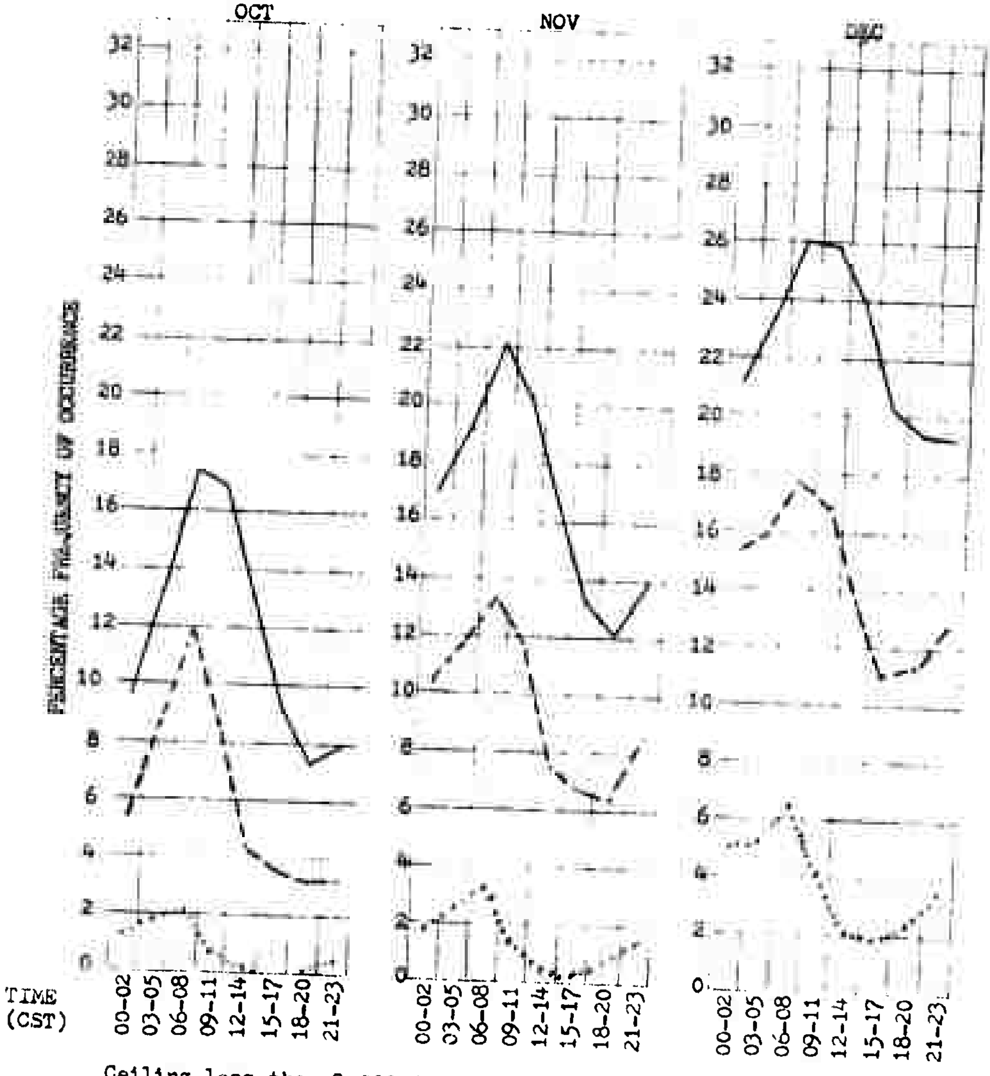


——— Ceiling less than 3,000 feet and/or visibility less than 3 miles.
- - - - Ceiling less than 1,000 feet and/or visibility less than 3 miles.
.... Ceiling less than 200 feet and/or visibility less than 1/2 mile.

CEILING VERSUS VISIBILITY

Data from Part "D", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46- Nov 67.

Figure 3-15

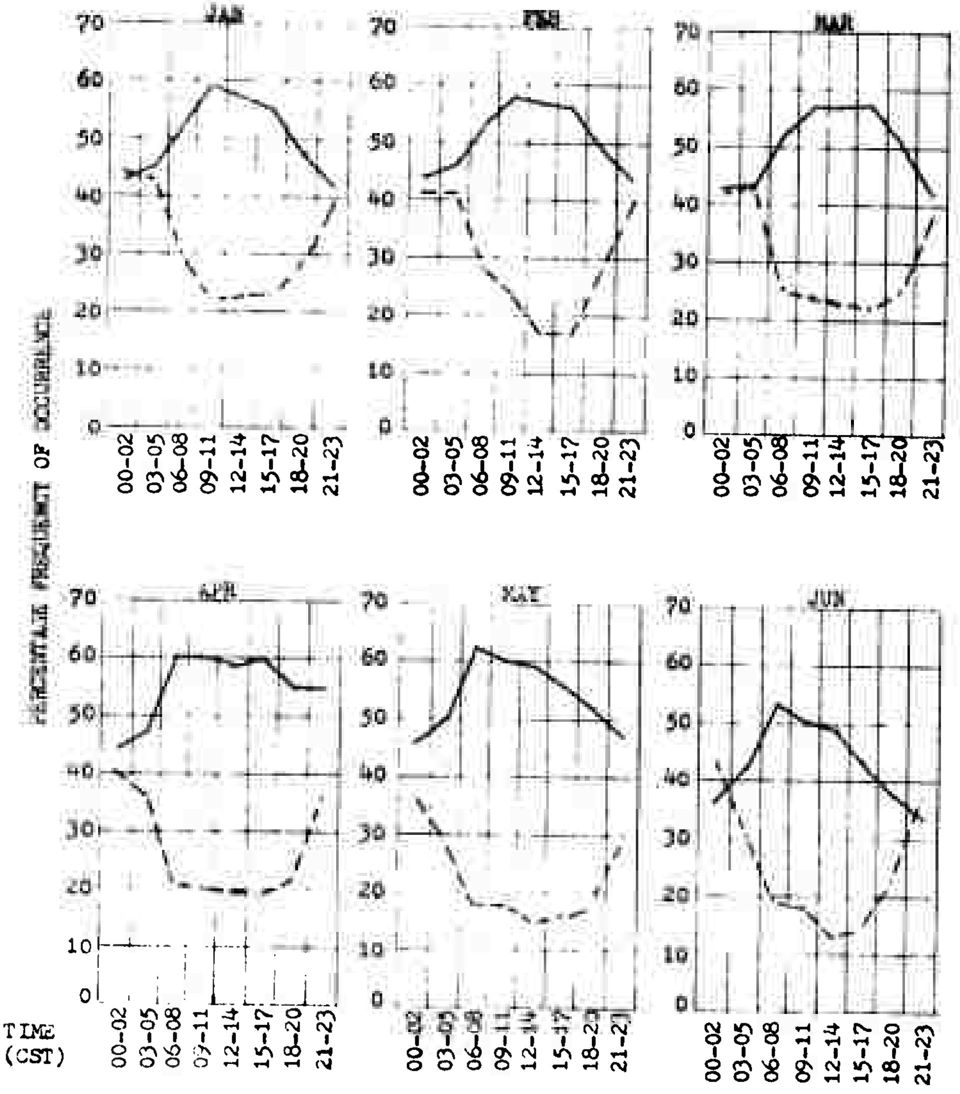


——— Ceiling less than 3,000 feet and/or visibility less than 3 miles.
- - - - Ceiling less than 1,000 feet and/or visibility less than 3 miles.
.... Ceiling less than 200 feet and/or visibility less than 1/2 mile.

CEILING VERSUS VISIBILITY

Data from Part "D", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Nov 67.

Figure 3-16

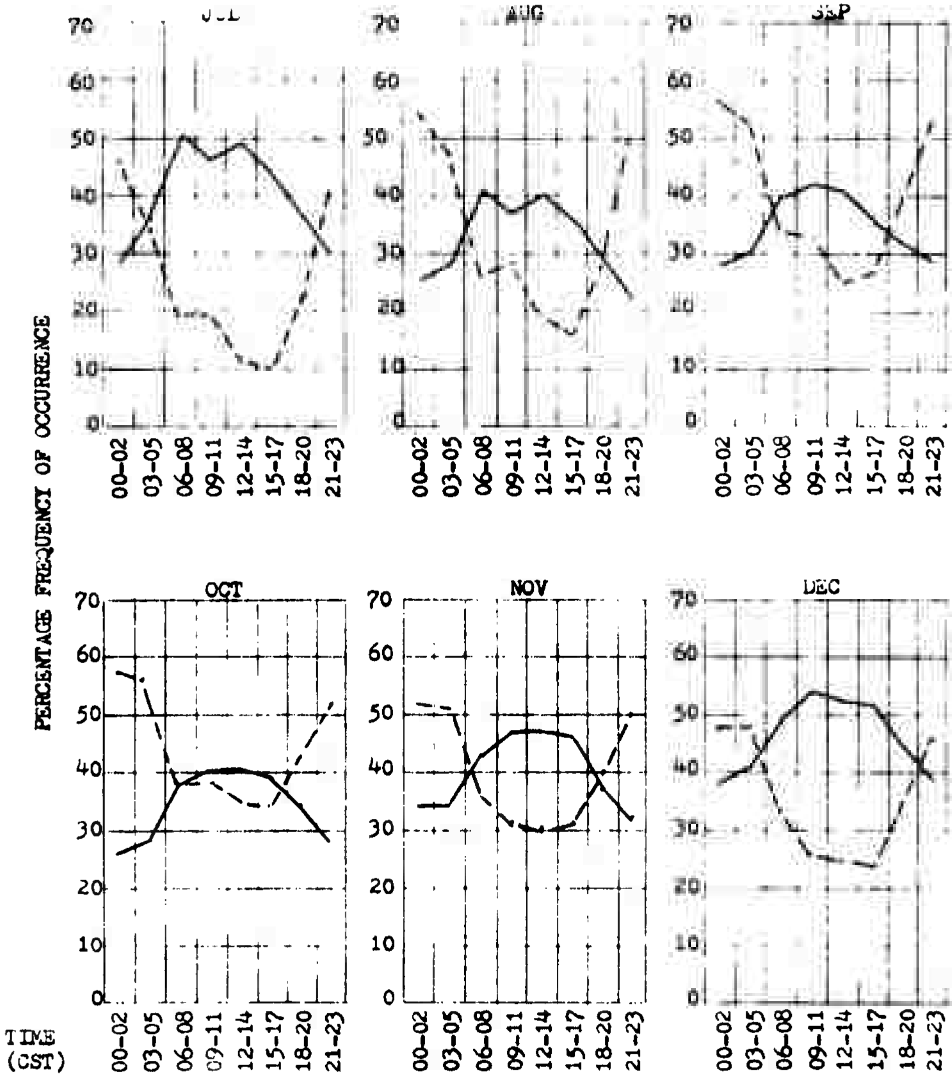


——— 6/10 -10/10 TOTAL SKY COVER, - - - - LESS THAN 1/10 TOTAL SKY COVER

PERCENTAGE FREQUENCY OF TENTHS OF TOTAL SKY COVER

Data from Part "D", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Nov 67.

Figure 3-17



______ 6/10- 10/10 TOTAL SKY COVER, - - - - LESS THAN 1/10 TOTAL SKY COVER

PERCENTAGE FREQUENCY OF TENTHS OF TOTAL SKY COVER

Data from Part "D", Revised Uniform Summary of Surface Weather Observations for the period Jan 43-Jan 46, Sep 46-Nov 67.

Figure 3-18

SECTION IV

LOCAL FORECAST STUDIES

TINKER AIR FORCE BASE, OKLAHOMA

1. Introduction: Three operationally important forecast problems exist at Tinker AFB: Two stratus situations and the severe weather associated with thunderstorms.

Forecasting the stratus and fog and related ceiling and visibility that occur with the northeasterly flow behind an arctic cold frontal passage is a frequent winter problem. These low weather conditions and those in the following paragraph affect landing minimums: circling minimums 500 feet and/or 1 mile, Runway 17 minimums 100 feet and/or 1/2 mile, and Runway 35 minimums of 100 feet and/or 1/4 mile.

The second problem is forecasting the stratus and fog and related ceiling and visibility that occur in southerly flow of low level moisture from the Gulf of Mexico. A very promising objective forecast study for this problem is included in this section.

The most important spring problem is forecasting thunderstorms at the terminal with at least two hours lead time and a minimum of lead time error. This problem is emphasized by the fact that the base is located in an area of some of the most frequent and potentially most hazardous thunderstorm activity in the nation.

In conjunction with thunderstorms is the hazard of lightning. The Base Weather Station is required to notify operations personnel when an electrical storm has reached within five miles of the base and again when the storm has passed, so that refueling can be suspended during the electrical storm.

LOCAL FORECAST STUDIES

SPECIAL SYNOPTIC STUDIES

2. Special Synoptic Studies:

a. Tornado Composite Charts

Composite charts for the surface, 850 mb, 700 mb, and 500 mb levels for Oklahoma and the Texas Panhandle, have been prepared for tornado occurrences in this area (Beebe, Robert G.: "Tornado Composite Charts", Monthly Weather Review, April 1956, United States Department of Commerce, Weather Bureau). Cases selected for inclusion in these composite charts were mostly based on the occurrence of three or more tornadoes within the outlined area during a 12-hour period. In all, 66 individual cases were used in the preparation of these charts with a total of 449 tornadoes reported.

The charts will provide a means for identifying larger scale features which are common to these situations. Also, composite charts clearly depict anomalies or departures from the "norm". The charts will not fit every severe weather situation in Oklahoma, but will provide a basic tool in forecasting this type of weather.

The interest in preparing the charts was in family-type outbreaks rather than isolated occurrences, so that tornado situations were selected on the basis of the occurrence of several tornadoes. A tornado situation was originally defined as one in which three or more tornadoes occurred within a specific area and at least two of these were separated by a distance of 100 miles or more. The tornado situations used were generally within the limits outlined above, but with some exceptions, including cases with two tornadoes within the area plus severe local storms (large hail, damaging windstorms, etc.). Tornado

situations were selected for study from occurrences during the tornado seasons of 1945 through 1953. The selection of times and dates for the data was made such that the upper-air data used were either from the 0300GMT or 1500GMT observations, whichever time immediately preceded the time of the first reported tornado in the area. These composites thus present a mean picture 0 to 12 hours before the outbreak of tornadoes.

<u>Summary</u>

General

1. A veering of wind with height occurs over the area.

2. The geostrophic winds, as measured by the contour spacing, increases with height.

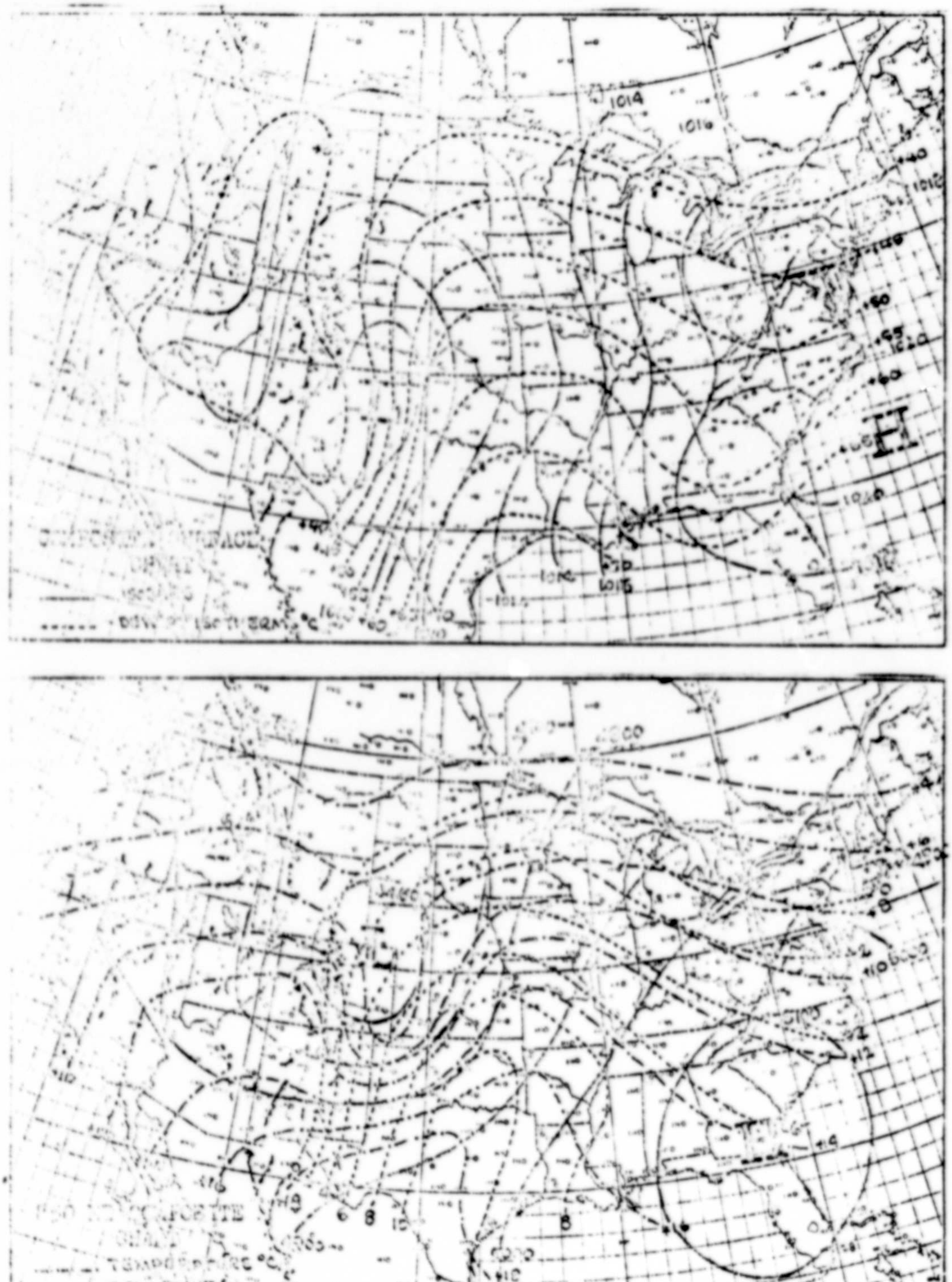
3. The Showalter stability index has a mean value of zero.

Surface Charts

1. The mean dew point is 60°F.

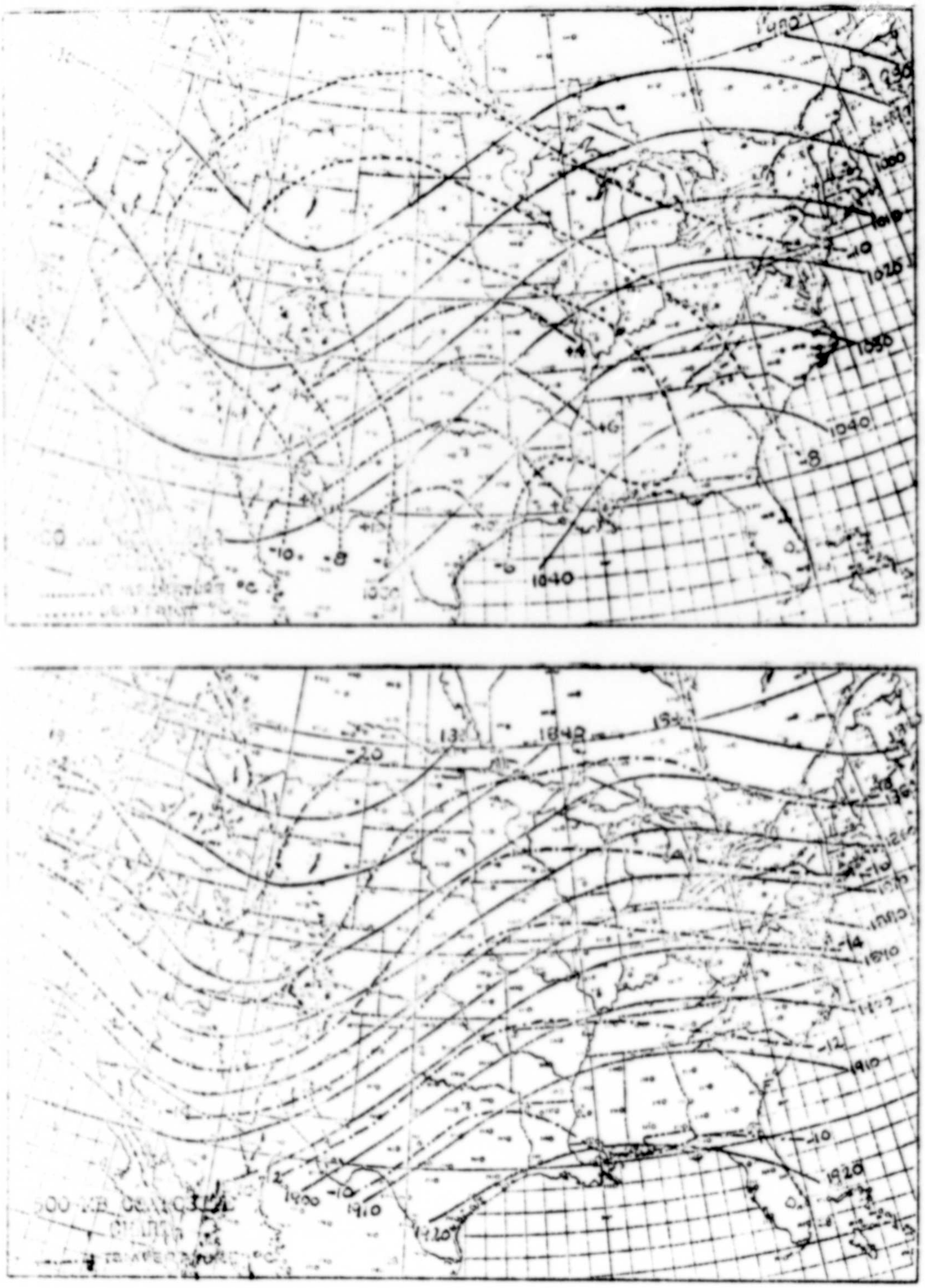
2. A moisture ridge is observed in all cases over Oklahoma and the axis is near the occurrences of severe storms.

3. Gradient winds are from a southerly direction in all cases with the average speed near 27 knots; the gradient is strong to the east of the occurrences and normally drops off rapidly to the west.



Composite maps from 66 tornado situations (449 tornadoes) that occurred in the Oklahoma area from March through June 1945 through 1953.

Figure 4-1



Composite maps from 66 tornado situations (449 tornadoes) that occurred in the Oklahoma area from March through June 1945 through 1953.

Figure 4-2

b. Low Level Wind Streams

From the investigation of the Low Level Jet undertaken at this detachment, the following important considerations relative to the phenomenon evolved:

(1) A better understanding of the low level wind field and the diurnal variations resulting from radiational heating and cooling has been obtained and this will serve to reveal the best parameters for surface wind objective forecasting techniques.

(2) Strong low-level wind shears often exist at Tinker from midnight to sunrise. These unusually strong shears are a significant hazard in landing large cargo-type aircraft—especially the modern high-wing-loading jets. This hazard must be understood by forecasters and operations personnel.

(3) The importance of this low level jet in the advection of low level instability and moisture during the severe weather season at Tinker is obvious. A study of thunderstorms and precipitation patterns during periods when the low level jet is favored, indicates a significant increase in the intensity of thunderstorms observed at night as opposed to those that develop in the afternoon.

More recent studies show that the low level jet occurs almost everywhere over the United States in clear weather during nighttime hours. However, the strongest and most frequent low level stream occurs in the Great Plains. Rather than looking like a river (as the high level jet appears), it is as if a sheet of rapidly moving air were sandwiched between slow moving layers of air, above and below (8WG Technical Note No. 60-3: "Low Level Wind Shear," 23 Nov 1960).

How the Low Level Jet Forms

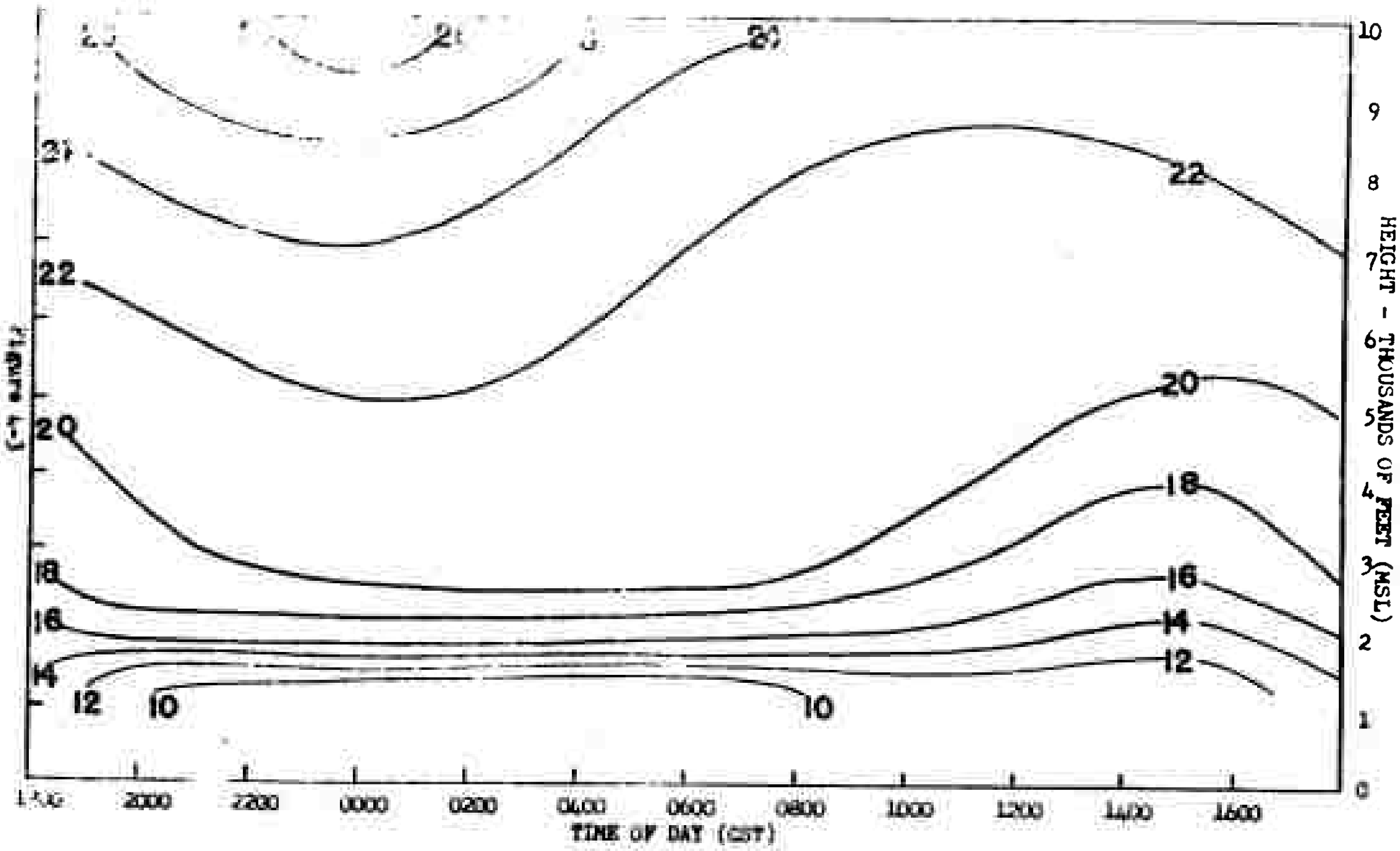
During the daytime, thermals rise above the heated ground and cause considerable mixing between the surface and upper layers (to a height of approximately 7,000 feet). Air going up is replaced by descending air parcels from higher levels which bring higher speeds with them. This additional momentum is imparted to the air in the surface layer, and the low level wind increases until the momentum from above is matched by the loss at the ground, which is produced by frictional drag. When this occurs, aircraft tend to float during mid-day landings. The gain in wind speed by the surface layers (surface to 300 feet) is equal to the loss by the upper layers minus the energy lost due to eddy viscosity (8WG Technical Note N. 60-3: "Low Level Wind Shear," 23 Nov 1960).

At night, convection ceases, and with it the exchange of momentum between the lower and upper layers. Deprived of additional momentum, and exposed to the frictional drag of the ground, the surface wind slows down. At the same time, the upper layer air is freed of its restraint (due to convection), and begins to speed up under the combined influence of the horizontal pressure gradient and the rotation of the earth. As a result, a maximum is reached near midnight at approximately 3,500 feet.

How to Forecast the Low Level Jet

The low level jet varies through a precise cycle, often for several days in sequence. During the sunshine or heating period of the day when conditions favor the momentum exchange necessary (see above), the wind speed gradient is very weak and constant from the surface to 7,000 feet; but during the night this pattern is radically changed.

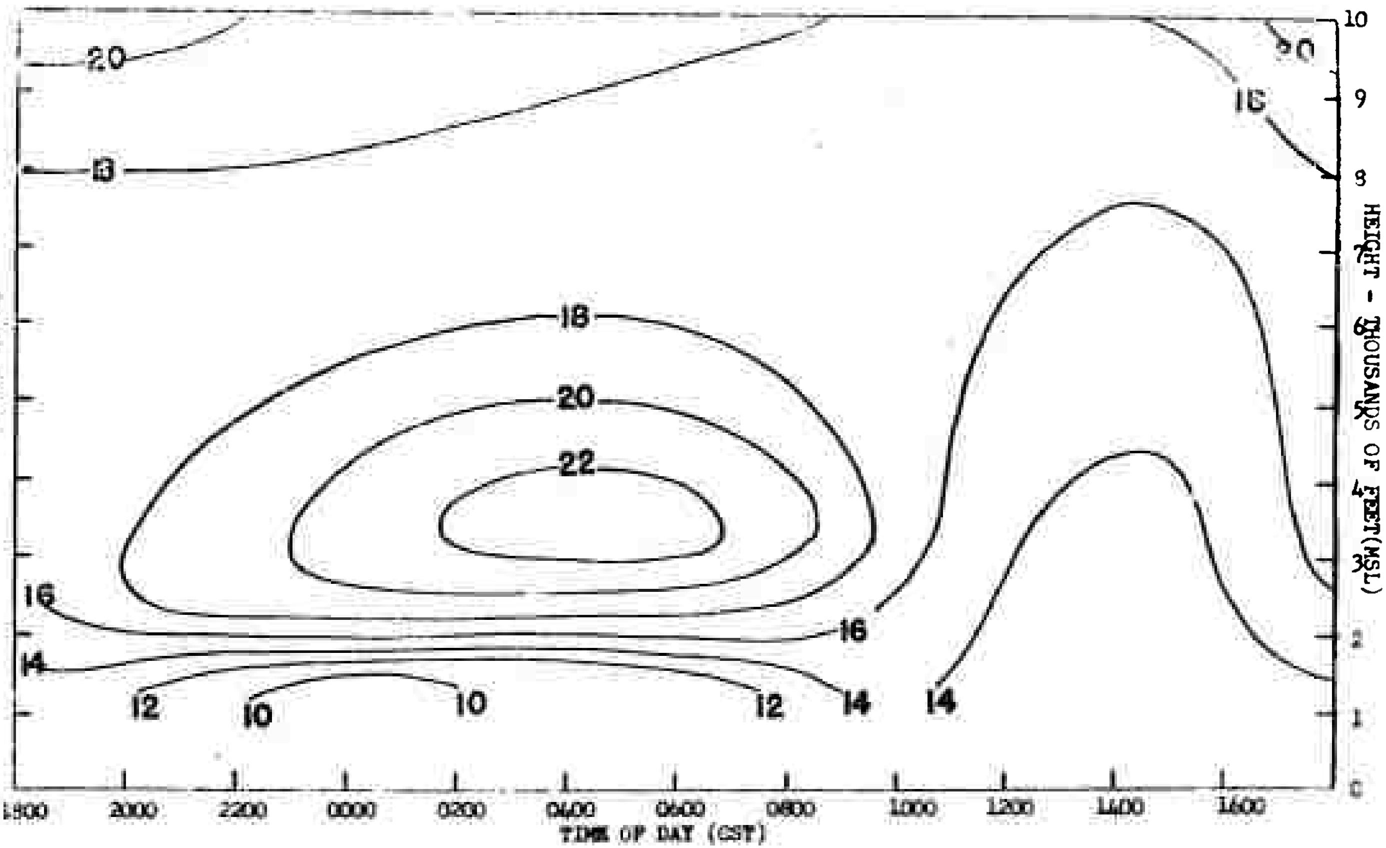
Figures 4-3, 4-4 and 4-5 are mean isotach analyses for the three seasons that we may most often expect the low level jet in this area: Jan - Mar, Apr - Jun and Jul - Sep. They were prepared from Oklahoma City and Tinker wind data and should be representative over the entire state of Oklahoma. They show the mean wind speed variations by the hour through the atmosphere from the surface up to 10,000 feet. They reflect the diurnal wind speed variations since they were prepared by averaging all observed wind speeds by the month, 1953 through 1958. Our investigations of this phenomenon at Tinker over the past six years reveal that the conditions favoring the formation occur approximately 60 percent of the nights during late Spring through Summer to about mid-Fall. Therefore, because the charts are mean charts including data for the other 40 percent of the wind patterns, the isotach values indicated on the charts should be approximately increased to give more realistic wind speeds for the occasions when low level wind streams actually develop. It has been determined that the most representative figure for the strength of the low level jet is obtained by doubling the isotach values indicated on the seasonal charts.



Mean wind velocities for Tinker[1] AFB, Oklahoma for January, February, and March.

From, Oklahoma City and Tinker AFB, wind data for 1953 through 1958.

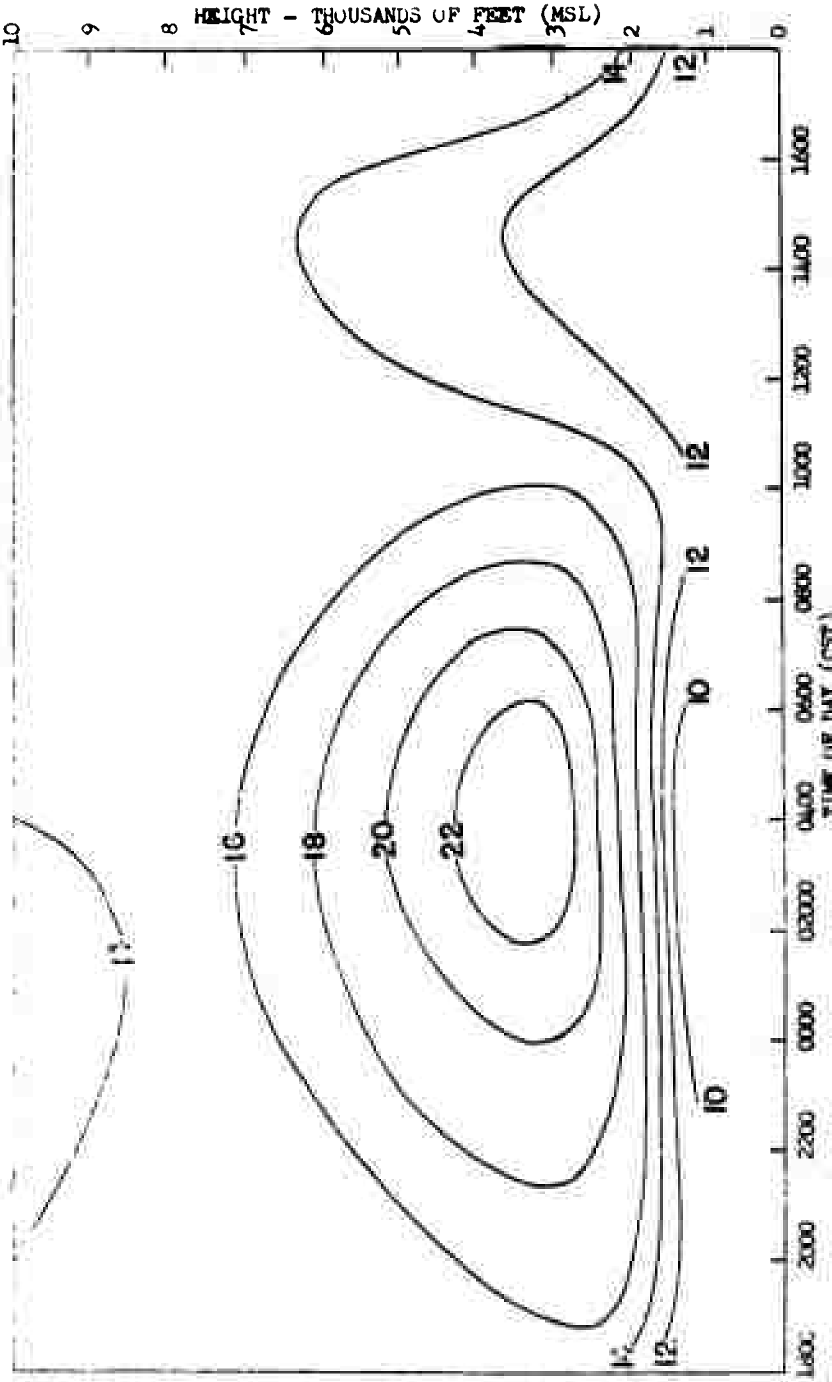
Figure 4-3



Mean wind velocities for Tinker AFB, Oklahoma for April, May, and June.

From, Oklahoma City and Tinker AFB, wind data for 1953 through 1958.

Figure 4-4



Mean wind velocities for Tinker AFB, Oklahoma for July, August, and September.

From, Oklahoma City and Tinker AFB, wind data for 1953 through 1958.

Figure 4-5

LOCAL FORECAST STUDIES

EMPIRICAL RULES

3. Rules of Thumb

Southerly gradient surface wind gusts can be forecast using millibar pressure differentials in the morning hours to forecast maximum afternoon gusts. For south to southwest surface wind gusts, multiply the pressure differential between Gage, Oklahoma (GAG), and McAlester, Oklahoma (MCL), by 4.5. For southeast winds, multiply the pressure difference between Hobart, Oklahoma (HBR), and Tulsa, Oklahoma (TUL), by 5.0.

LOCAL FOREAST STUDIES

OBJECTIVE FORECASTING METHODS AND AIDS

4. Stratus Study (by SMSgt Thomas W. Grant)

a. Background: IFR (below 1000/3) versus VFR conditions at Tinker AFB are operationally significant. This objective method is designed to increase the capability of the duty forecaster in predicting a downward trend, VFR to IFR, in weather conditions at Tinker. This study is designed to predict IFR conditions caused by the following situations:

(1) Frontal over-running, usually following a continental polar frontal passage with upslope winds surface to 2,000 feet from the north through the east.

(2) Low level saturation from precipitation caused by a trough aloft. In this case the 2,000-foot wind is usually southwesterly.

(3) Gulf stratus which forms when the low level wind flow over Texas is established with a southerly trajectory off the Gulf. With this trajectory, low level moisture, or stratus, is advected upslope to Tinker. The wind direction is usually east-southeast through south; however, brief occurrences have been observed with downslope south-southwest surface winds.

b. The Forecast Problem: Using the information available from the 0000Z observations (surface, RAOB, and 850mb chart), determine if the Tinker ceiling will be below 1,000 feet and/or visibility less than three miles during the following 24 hours ending at 0000Z.

c. Predictor Parameters Used and Rejected:

(1) Onset time of IFR stratus versus the 00Z 2,000-foot wind speed. No correlation could be found.

(2) Confluent/difluent character of the upstream 2,000-foot wind at 00Z using an overlay for objective measurement. This method met with little success and depended too much upon a subjective streamline analysis prior to applying the overlays.

d. Predictor Parameters Used:

(1) The 00Z 2,000-foot Tinker wind direction versus the 00Z Tinker temperature-dewpoint spread.

(2) The 00Z 2,000-foot Tinker wind direction versus the 00Z average temperature-dewpoint spread between the surface and 850mb for an upstream station. The upstream station is determined from the 00Z 2,000-foot Tinker wind direction and may be either Little Rock (LIT), Shreveport (SHV), or Fort Worth (GSW).

(3) During the summer half of the study, a subjective determination for confluence/difluence used when all objective parameters arrive at "MAYBE."

e. Explanation of the Charts Used: This study is broken down into two time periods, 1 November through 31 March and 1 April through 31 October. Two sets of similar nomograms are used for each time period. The first nomogram uses the Tinker 00Z 2,000-foot wind direction as the abscissa and the Tinker 00Z surface temperature-dewpoint spread (°F) as the ordinate (see chart 1, figures 4-7 and 4-8). The result is either "Yes", "No," or "Maybe". Only if "Maybe" is indicated do you go on to the second nomogram. This nomogram (see chart 2, figures 4-7 and 4-8) uses the Tinker 00Z 2,000-foot wind direction as the abscissa and the 00Z average surface to 850mb temperature-dewpoint spread from an upstream station (LIT, SHV, or GSW). The upstream station is determined from the Tinker 2,000-foot wind direction. For the winter season, an objective "Yes" or "No" is determined on the second nomogram; but for the summer season, the second chart may also indicate "Maybe". In this case, a third step is required; that of doing a streamline analysis of the 2,000-foot winds within about a 200-mile radius of Tinker, and subjectively determining if the upstream flow is difluent, neutral, or confluent. Finally, if difluent,

the forecast is "No", but if the flow is neutral or confluent the forecast is still "Maybe" and the final decision is left up to the forecaster's experience. This, of course, leaves part of the study to subjective decision making, but forcing an objective answer of "Yes" on this third step, when neutral or confluent flow is observed, decreases verification results. Figure 4-6 gives step by step procedures for making a forecast using this study.

f. Limitations: The situations for which this study is to predict IFR weather are covered in paragraph a. IFR observations caused by thunderstorms are not counted in this study. Post-frontal stratus is a situation that is included and is difficult for this study to predict because of the resulting airmass and wind changes. The study will often say "No" prior to frontal passage while IFR conditions may be observed after frontal passage.

g. Evaluation and Verification: Dependent data was used from the periods 1 April 1968 through 31 October 1968 for the summer charts and 1 November 1968 through 31 March 1969 for the winter charts. Separate scatter diagrams were constructed for each time period and the final charts were configured according to best fit. Independent data to test the study were taken from the period 1 April 1969 through 31 March 1970. Statistics for this study are presented in Table 4-1 (p IV-20).

h. Future Study: Future investigations should attempt to separate the third step for the summer period forecast into an objective yes-no forecast. Also an attempt should be made in determining a method which will give the onset time of the IFR conditions.

VERIFICATION STATISTICS

Dependent Data	Independent Data

Dependent Data — 1 Apr 68 - 31 Oct 68

OBSERVED \ FORECAST	Yes	No	Total
Yes	29	4	33
No	18	163	181
Tot	47	167	214

% Correct 90%
% Yes Correct 62%
% No Correct 98%
Heidke Skill Score +0.66

Independent Data — 1 Apr 69 - 31 Oct 69

OBSERVED \ FORECAST	Yes	No	Total
Yes	22	18	40
No	15	159	174
Tot	37	177	214

% Correct 85%
% Yes Correct 59%
% No Correct 90%
Heidke Skill Score +0.48

Dependent Data — 1 Nov 68 - 31 Mar 69

OBSERVED \ FORECAST	Yes	No	Total
Yes	49	3	52
No	10	89	99
Tot	59	92	151

% Correct 91%
% Yes correct 83%
% No Correct 97%
Heidke Skill Score +0.82

Independent Data — 1 Nov 69 - 31 Mar 70

OBSERVED \ FORECAST	Yes	No	Total
Yes	42	12	54
No	8	89	97
Tot	50	101	151

% Correct 87%
% Yes Correct 84%
% No Correct 88%
Heidke Skill Score +0.71

Table 4-1

STRATUS STUDY STEP BY STEP PROCEDURES

For the period 1 Apr - 31 Oct use figure 4-7 and for 1 Nov - 31 Mar use figure 4-8.

1. TIK 00Z 2000 foot wind direction: ____________

2. TIK 00Z surface temp - dewpoint spread (^{o}F): ____________

3. Enter chart 1 with the data from steps 1 and 2 above. Chart 1 says: ____________

4. If chart 1 says "YES" or "NO" stop; if it says "MAYBE" continue.

5. Using the wind direction from step 1 compute the average temp - dewpoint spread from the surface to 850mb for the applicable station in ^{o}C:

Wind Dir	Station	
075° - 120°	LIT	____________
125° - 160°	SHV	____________
165° - 210°	GSW	____________

6. Enter chart 2 with the data from steps 1 and 5 above. Chart 2 says: ____________

7. If chart 2 says "YES" or "NO" stop; if it says "MAYBE" continue.

8. Streamline an area about 200 miles radius of TIK on the 2000 foot wind chart. Analyze the wind field over TIK for confluent, neutral, or difluent flow. If the wind is difluent forecast "NO". If the wind is neutral or confluent the forecast is "MAYBE"; use subjective reasoning for a final "YES" or "NO".

Figure 4-6

1 April through 31 October

CHART 1

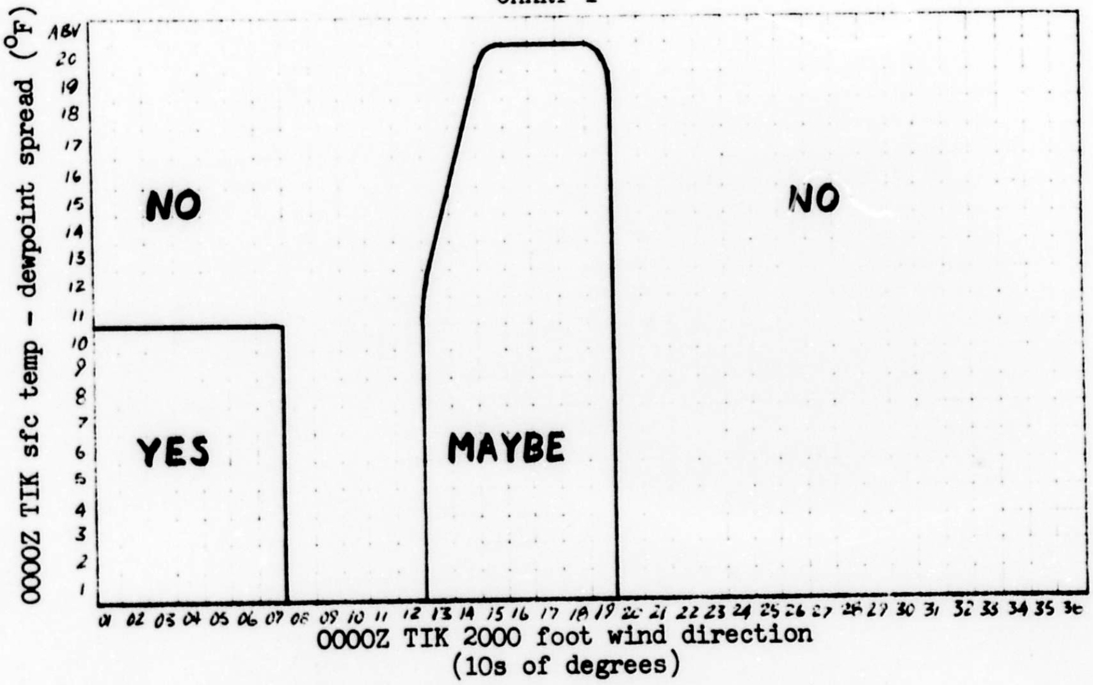


CHART 2

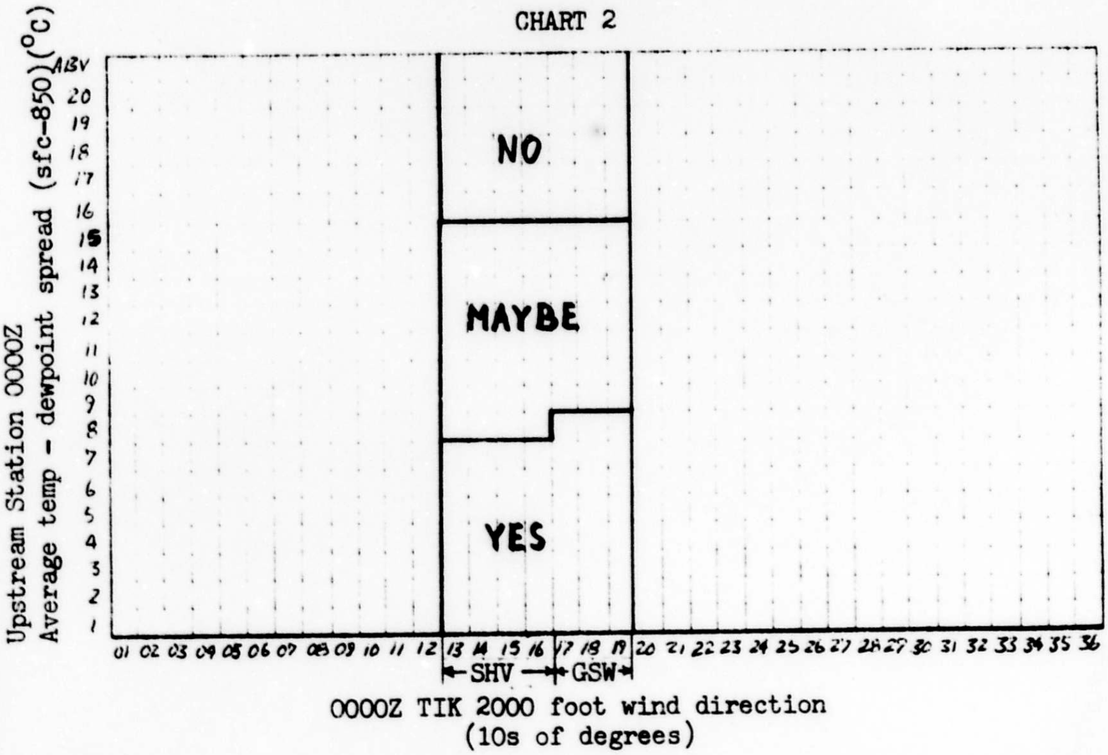


Figure 4-7

1 November through 31 March

CHART 1

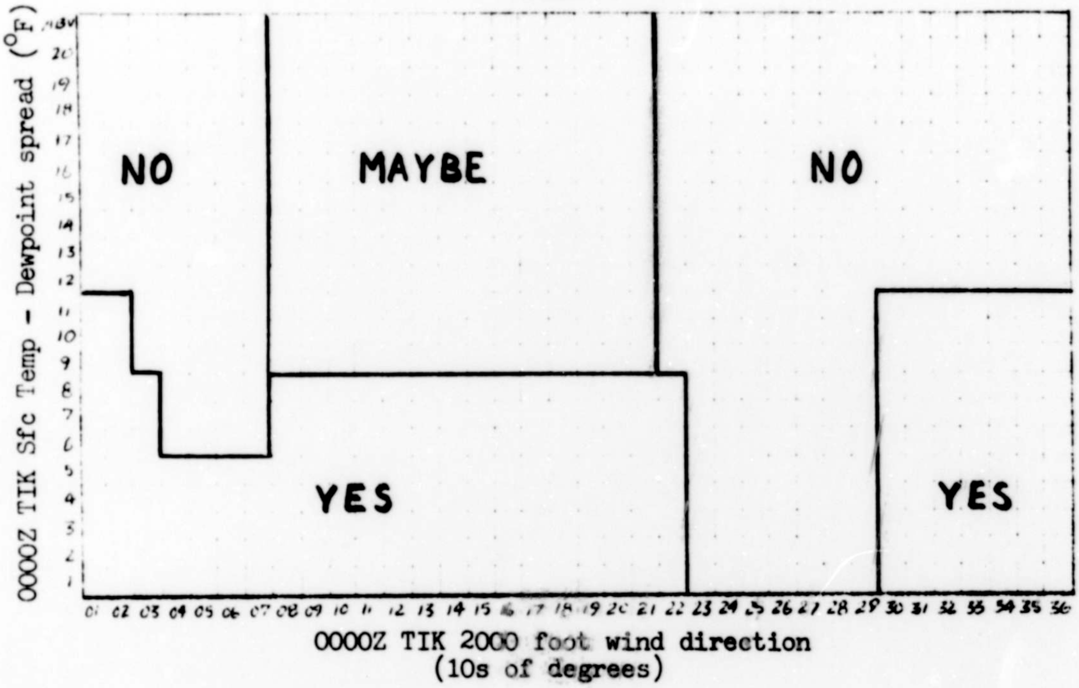


CHART 2

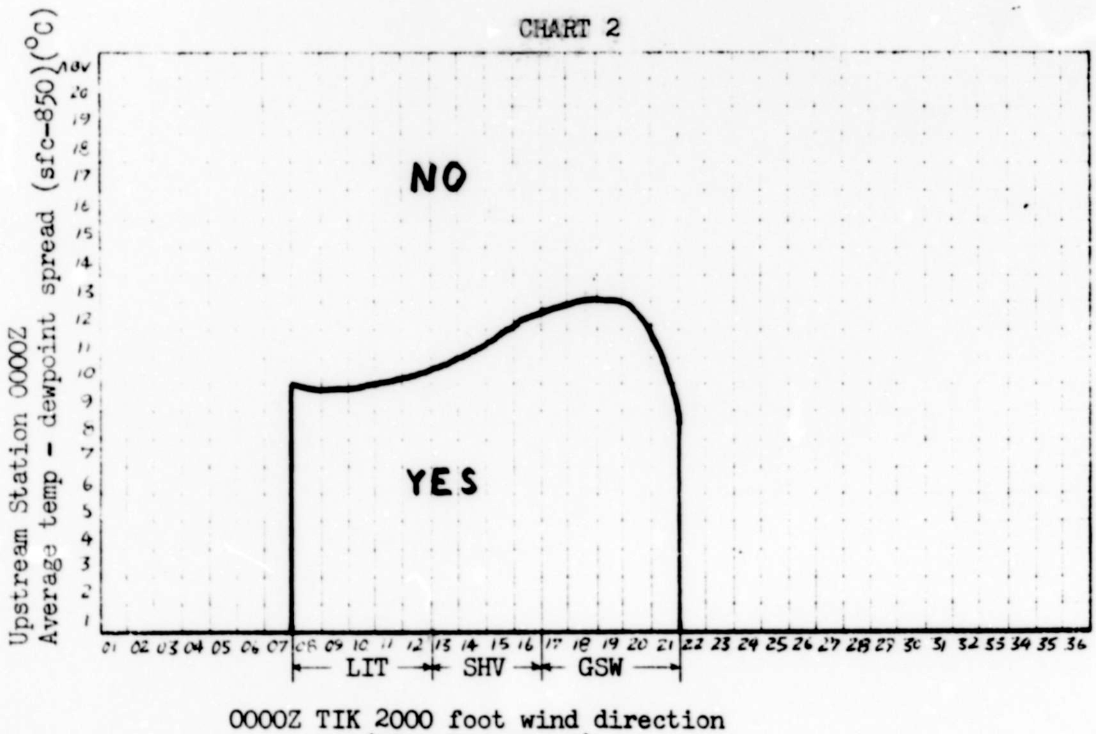


Figure 4-8

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13. ABSTRACT

This reference file discusses factors affecting the Weather at Tinker AFB, OK. Included are location and topography, weather controls, climatic aids, and local forecast studies.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Climatic Data						
Tinker AFB, OK						
Local Forecast Studies						

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